“THE NEXT STEP: A STUDY ON RESILIENCY IN COMMAND AND CONTROL”

BY

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The undersigned certify that this thesis meets master's-level standards of research, argumentation, and expression.

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ABSTRACT

Centralized command and control, particularly since the 1991 Gulf War, has enabled American airpower to dominate the battlefield. Reinforced by history and empowered by information technology, the Air Force has allowed centralized control to bottleneck operational capability at the Air Operations Center, providing a strategic weakness for an adversary to exploit. The Air Force, as the lead service in command and control of airpower, is responsible for providing a resilient solution that maximizes airpower effectiveness even when contested by an adversary.

This study analyzes three organizational concepts for providing resiliency in command and control: redundancy, distributed, and organic. A framework developed from doctrine, history, and existing operational problems provides the analytical reference to compare these three concepts. The conclusion of this study is that the organic approach is a better solution for the future of command and control of airpower against an increasingly credible list of adversaries. This study recommends and provides an incremental approach to organizing, training, and equipping for organic command and control. Ultimately, organic design is an evolutionary concept for command and control of airpower that assures the United States maintains a decisive advantage against its adversaries.

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Success is never final.

John Wooden
UCLA Basketball Head Coach, 10 Time NCAA Champion

The historic success of airpower in the 1991 Gulf War was due in large part to the realization of the Air Force's long held dream of centralized command. Having proven itself in combat, the Air Force sought to institutionalize its master tenant of "centralized control, decentralized execution" in the conduct of Joint airpower. Aided by technology and the information age, centralized control reached new depths as generals watched the battlefield in Iraq and Afghanistan live from thousands of miles away. Nearly a quarter of a century later, centralized control continues to provide unequivocal success for airpower in combat.

This success is not lost on potential adversaries. If airpower's success is built on centralized command and control, then disruption of command and control is the key to undermining United States interest around the world. Disruption is becoming increasingly achievable as nations develop counter space and cyber capabilities to prevent the flow of information required for centralized control. In the future, the resiliency of command and control when contested will determine the effectiveness of airpower to defend national security interests.

As a result, from senior leaders to component staffs, the Air Force is questioning the way it does business. This study starts at the beginning of airpower to determine why the Air Force evolved into centralized command and control and to glean lessons for the future. Current solutions, doctrine, assumptions, and theoretical concepts are

proposed and challenged in order to understand the limits in adaptability. Ultimately, the goal of this study is to find a pragmatic and effective solution for resiliency in the command and control of airpower in a contested environment.

Chapters 1 and 2 provide the foundational background for the command and control discussion provided throughout this monograph. Chapter 1 provides contemporary Joint definitions and doctrinal concepts including the master tenant, mission command, and relevant components of John Boyd's command and control theory. The second chapter walks through the evolution of the centralization of airpower taking special note of limitations, assumptions, and institutional influences that continue today.

Building on the concepts and history provided, Chapter 3 looks at the impact of centralization and the vulnerabilities of the current command and control system. This chapter pits the limitations of the current system against a capable adversary to develop an understanding of the inherent weaknesses. Finally, this chapter develops a framework from history and the current operational problem for critical analysis of resiliency solutions.

Chapter 4 compares three command and control resiliency solutions using the framework previously developed: redundancy, distributed, and organic. While Air Force doctrine defines redundancy and distributed, organic is a non-doctrinal concept provided for consideration. This chapter defines each solution by their conceptual approach, authorities provided during contingency operations, and the physical structure of the Air Operations Center (AOC).

Lastly, Chapter 5 provides recommendations for the future. It utilizes an incremental approach to developing resiliency in command and control of airpower.

Chapter 1

Command and Control: Definitions and Concepts

The purpose of this chapter is to lay a foundation of definitions, theories, and doctrinal concepts necessary for the argument throughout this paper. By connecting doctrine with military theory, the intent is to enlighten the discussion of resilience in command and control of airpower in a contested environment. Lastly, this chapter highlights key differences in contemporary joint doctrine between the Air Force and the other services in order to understand and challenge their underlying assumptions.

Command and Control Definitions

In order to facilitate a common vernacular, the services have unified their definition of command and control. Command and control, as defined in all United States service doctrines and in Joint Publication 1, is "the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Also called C2."[1] While the overarching Joint definition and the foundational concepts behind command and control are the same, each service approaches C2 in a unique fashion. Within the Air Force, the command and control concept is uniquely codified as "centralized control, decentralized execution," long thought of by airmen as the master tenet.[2]

While military academics and doctrine often defines command and control as a term by itself, it is useful for discussion to break it down into

[1] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 8 November 2010, as amended through 15 January 2015, 45.
[2] Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?,* Research Paper 2009-1 (Maxwell AFB, AL: Air University Press, 2009), 7. This section provides a short history of the Air Force's master tenet.

its distinct components for analysis. Joint publication defines command as lawful authority and command orders as "the will of the commander expressed for the purpose of bringing about a particular action."[3] Martin Van Creveld, notable military theorist and author of *Command in War,* states that the will of the commander should be unambiguous and clear in its intent to the subordinates.[4] Van Creveld's work divides the responsibilities of command into two components: function and output.[5] The first component, function, focuses on coordination of everything required for a military force to exist such as logistics and administrative actions like military justice.[6] The second component, output, is how a commander conducts military force through intelligence gathering, planning, and monitoring of operations.[7] This study focuses on the output of command to subordinate forces, specifically the planning and conduct of air operations.

Control is how the commander organizes and employs forces, gathers intelligence, assigns tasks, designates objectives, and gives authoritative direction necessary to conduct operations.[8] Control not only provides direction but it is also a feedback cycle providing an assessment of actions and helping redirect forces in concert with

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[3] JP 1-02, *Department of Defense Dictionary of Military and Associated Terms,* 40.
[4] Martin Van Creveld, *Command in War* (London: Harvard University Press, 1985), 8.
[5] Martin Van Creveld does not explicitly separate command and control into separate definitions but utilizes the term "command" to define the "manifold of activities" involved in command, control, communications (C3). However, despite a difference in the approach to defining command and control, the author provides Van Creveld's thoughts in this section as additive value to modern doctrinal definitions. Martin Van Creveld, *Command in War*, 7.
[6] Martin Van Creveld, *Command in War*, 6.
[7] Martin Van Creveld, *Command in War*, 6.
[8]. The author utilized components of Martin Van Creveld's *Command in War*, Air Force Doctrine Annex 3-30, and Joint Publication 1-02 definitions to develop a unified definition of control. JP 1-02's definition of control as "authority that may be less than full command exercised by a commander over part of the activities of subordinate or other organizations" is insufficient for this discussion. Van Creveld, *Command in War*, 7; Air Force Doctrine Annex 3-30, *Command and Control*, 7 November 2014, 6; JP 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 181.

command.[9] However, control is much more complex than just a feedback cycle; it is an increasingly complex iterative process that provides constant information at different rates while alternatively providing direction for fielded forces. The control system includes all of the organizational, procedural, and technical means at the disposal of the commander.[10]

Command and Control Concepts and Doctrine

Looking beyond definitions, there are a number of concepts, doctrinal and academic, that illuminate the study of command and control. Throughout this study, Col. John Boyd's *Observe-Orient-Decide-Act* (OODA) Loop is utilized to define critical elements of the command and control process that must be accounted for when studying the problem or proposing a solution. Lt Col John Betts' C2 mental model visually communicates the Air Force's command and control master tenant including the impact of centralization versus decentralization. Lastly, this section outlines Joint command and control doctrinal concepts of mission command and intent with specified differences between air, land, and maritime components addressed. This monograph utilizes the doctrinal and academic concepts provided in this section to advance specific discussion elements for command and control in a contested environment.

OODA Loop

As an academic concept, Col. John Boyd's (OODA) Loop provides a useful tool for discussing command and control's separate but dependent functions (see Fig. 1-1).[11] Nicknamed as a C2 Loop by Boyd himself, it

[9] Air Force Doctrine Annex 3-30, *Command and Control*, 6.
[10] Van Creveld, *Command in War*, 10.
[11] This section derives the OODA loop discussion from John Boyd's briefings and Marine Corps Doctrine, specifically Marine Corps Doctrine Pamphlet (MCDP) 6*: Command and Control*. Although *Air Force Doctrine Document 3-0 Annex: Operations and Planning* mentions the OODA Loop under cyber operations, there is not an Air Force or

provides a framework for understanding the required elements for effective command and control and their impact on the process.[12] Discussion of the OODA Loop during conflict begins with forces who *Observe* the environment and situation.[13] The context of that O*bservation*, altered by a number of factors including culture, biases, and missing or incorrect information leads to "estimates, assumptions, analyses, and judgments about the situation in order to create a cohesive mental image." In the framework of the OODA Loop this is known as *Orient.*[14] From *Orient*, commanders make D*ecisions*, and subordinates *Act*. The *Act* changes the situation and corresponding *Observation* as the loop continues.

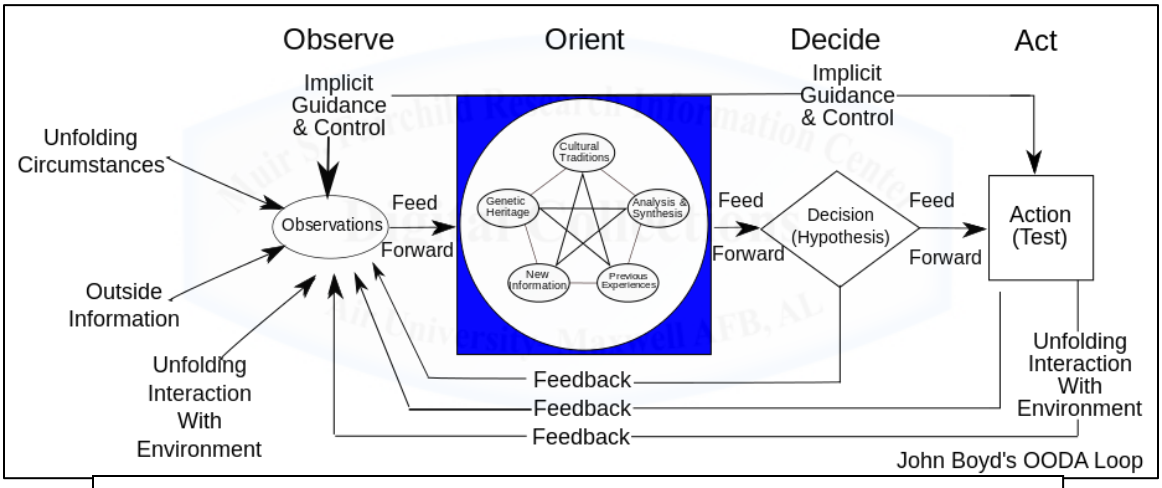

Fig. 1 The OODA Loop (Wiki Commons)

The OODA Loop is not singularly cyclical as each element of the OODA Loop interacts with the other components. For instance, John

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Joint doctrinal explanation of how to understand the OODA Loop beyond "observe, orient, decide, and act". Despite a lack of development in Air Force doctrine, the OODA loop is one that airmen are familiar with and taught during Air Force Professional Military Education (PME). OODA loop image from Wikipedia, accessed 4 March 2015, http://en.wikipedia.org/wiki/OODA_loop#mediaviewer/File:OODA.Boyd.svg.

[12] John Boyd, "Organic Design for Command and Control", briefing slides dated May 1987, slide 26.

[13] The author has italicized John Boyd's elemental components of the OODA Loop to provide emphasis and prevent confusion. Additionally, the author interchanges verb and noun form of the elements to improve readability.

[14] Marine Corps Doctrine Pamphlet (MCDP) 6, Command and Control, 4 October 1996, 63.

Boyd refers to the *Orient* element of the OODA Loop as the "*Schwerpunkt*," or center of gravity, of command and control.[15] It shapes how an organization *Observes*, *Decides*, and *Acts*.[16] As such, how a commander and staff conducts and shares *Orientation* is critical to the effectiveness of the command and control process.

The commonly derived lesson from the OODA Loop is that the speed of execution provides a relative advantage over the adversary at all levels of warfare.[17] Operating "inside" an adversary's OODA Loop, or at a faster rate, will "fold [an] adversary back inside himself so that he cannot cope with events/efforts as they unfold."[18] Although the critical nature of speed in decision-making is important, John Boyd was careful to intimate that speed without shared mental images and impressions that "matched the activity of the world" would "lead to confusion, disorder and ultimately chaos". [19] Therefore, it is not just speed that is important but also the quality of understanding with which organizations make decisions. This study utilizes the OODA Loop as a framework to simplify the discussion on the command and control decision-making process.

Centralization and a C2 Mental Model

While the OODA Loop provides a framework for discussion on how an organization makes command and control decisions, the level of centralization of that organization is important to understand the responsibility and extent to which commanders at all levels must conduct the individual elements of the loop. When discussing the degree to which an organization centralizes, two terms are important: depth of command and height of execution. Depth of command, as defined by Lt

[15] John Boyd, "Organic Design for Command and Control", slide 16.
[16] John Boyd, "Organic Design for Command and Control", slide 16.
[17] John Boyd, "Patterns of Conflict", briefing slides dated December 1986, 7.
[18] John Boyd, "Patterns of Conflict", 7. John Boyd, "Organic Design for Command and Control", slide 7.
[19] John Boyd, "Organic Design for Command and Control", slide 9, 16.

Col Michael Kometer in *Command in Air War: Centralized Versus Decentralized Control of Combat Airpower*, is "a measure of the extent to which diverse players at the scene of battle can be prioritized, and redirected when the situation calls for it."[20] Stated more simply, this depth is the ability for commanders to reach down through multiple command levels in order to direct operations. As technology advanced, enabling direct influence over an increasingly larger number of subordinates' from anywhere in the world, so has depth of command.

While depth of command is the ability for senior commanders to reach down through multiple levels to control subordinate actions, height of execution is the ability for lower level commanders to own and execute those control processes by themselves. Increased capability for subordinate commanders to coordinate and act on their own increases the height of execution and the potential for decentralized control. The zone where depth of command and height of execution overlap is the zone of adaptive control, as laid out by Lt Col William Betts in "Airpower's Master [Tenet] and Anti-Access/Area Denial: Hope Is Not A Course of Action."[21] The zone of adaptive control provides flexibility for the senior commander to set the level of centralization based on conditions, as well as through the authorities given to the subordinate commander. If the depth of command, either set by the commander or determined by conditions, is less than the height of execution, then a "responsibility/capability gap exists: the commander is asking subordinates to own processes that are beyond their capability."[22] Senior commanders avoid this gap by matching authorities with subordinate capability. Lt Col Betts provides a useful mental model of the master

[20] Michael W. Kometer, *Command in Air War: Centralized Versus Decentralized Control of Combat Air Power* (Maxwell AFB, AL: Air University Press, 2007), 16.
[21] Spelling changed to match authors spelling of "master tenet" for consistency.
[22] William Betts, "Airpower's Master Tennent and Anti-Access/Area Denial: Hope Is Not a Course of Action" (Thesis Air War College, Air University, 2014), 6.

tenet and centralization in a graphic representation for the concept under hypothetical conditions (see Fig. 1-2).[23]

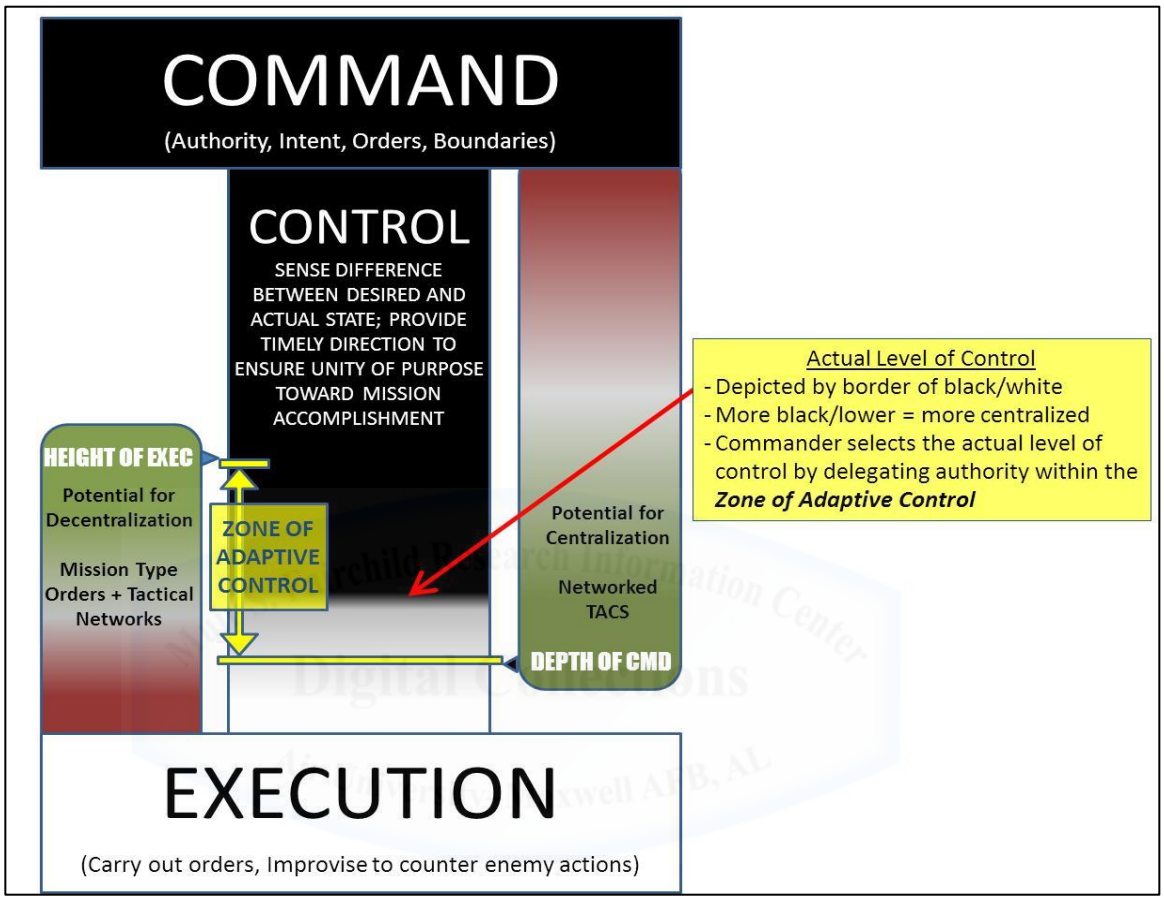

Fig. 2 The Betts' C2 Mental Model

Decentralized Control and Mission Command

The ability to conduct decentralized operations has become a focal point for command and control discussion among all of the services, particularly as the pace of warfare increases. Decentralized control is conceptually codified in Joint Publications as mission command and mission-type orders. All three Joint Publications on Command and Control for Air, Land, and Maritime forces reference mission command and mission-type orders as the preferred method for decentralized

[23] Betts, "Airpower's Master Tennent and Anti-Access/Area Denial," figure 2, 5.

command and control. *Joint Publication 3-31 Command and Control for Joint Land Operations* is the authoritative joint publication on mission command and best defines the concept (bold is author's added emphasis):

> As joint land operations tend to become decentralized, mission command becomes the preferred method of C2. **Mission command is the conduct of military operations through decentralized execution based upon mission-type orders**. It empowers individuals to exercise judgment in how they carry out their assigned tasks and it exploits the human element in joint operations emphasizing trust, force of will, initiative, judgment, and creativity. Successful mission command demands **that subordinate leaders at all echelons exercise disciplined initiative, acting aggressively and independently to accomplish the mission**. Orders are focused on the purpose of the operation rather than the details of how to perform assigned tasks. **Essential to mission command is the thorough knowledge and understanding of the commander's intent at every level of command and a command climate of mutual trust and understanding**. Under mission command, commanders issue mission-type orders, use **implicit communications**, delegate most decisions to subordinates wherever possible and minimize detailed control.[24]

There are a few key factors worth noting in the land component approach to mission orders. Of primary importance is the realization that mission orders do not force decentralization, they enable it. One of the primary causes for decentralization is the assumption that loss of communication with subordinate commanders and forces is highly likely. According to JP 3-31, "complex physical environment of the operational area may restrict the performance of some technologies supporting C2, including line of sight communications and overhead surveillance."[25] As a result, mission command enables continued ability to conduct

[24] Joint Publication (JP) 3-31, *Command and Control for Joint Land Operations*, 24 February 2014, IV 8-9.
[25] JP 3-31, *Command and Control for Joint Land Operations*, IV 8

operations despite factors beyond the control of land force component commanders.

A second component of both the land force and maritime definition of mission command is that the definition refers to "subordinate leaders at all echelons," a reference notably missing from the air component definition.[26] The air component joint doctrine not only avoids an "all echelon" definition, it explicitly designates subordinates as those at the tactical level only involved in specific mission sets (i.e., close air support, personnel recovery, etc.).[27] This doctrinal limitation on mission command for the air component undermines the potential for decentralization and height of execution at command levels not explicitly designated.

Air Force basic doctrine further reinforces the echelon limitations of mission command in its explanation of the master tenet, centralized control and decentralized execution. According to *Air Force Basic Doctrine*, centralized control means strategic and operational level control by a single airman at the joint force air component commander (JFACC) level.[28] Centralized control provides flexibility and versatility for the air component commander who is able "to respond to changes in the operational environment and take advantage of fleeting opportunities."[29] Air Force doctrine provides no allowance for multiple echelon initiative at the operational level.

Under decentralized execution, Air Force doctrine defines the tactical level as the appropriate level for subordinate commanders to

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[26] Joint doctrine defines land component mission command at "all echelons" in JP 3-31, *Command and Control for Joint Land Operations* page IV-8. Maritime component mission command at "all echelons" is defined in JP 3-32, *Command and Control for Joint Maritime Operations,* page I-2.
[27] Joint Publication (JP) 3-30, Command and Control of Joint Air Operations, 10 February 2014, I-3.
[28] Air Force Doctrine Volume 1, *Air Force Basic Doctrine*, 27 February 2015, 67.
[29] Air Force Doctrine Volume 1, *Air Force Basic Doctrine*, 68.

exploit “situational responsiveness” and “fleeting opportunities.”[30] Through decentralized execution, designated lower level commanders and other “tactical-level decision makers” execute initiative based on disciplined initiative and tactical flexibility.[31] Doctrine defines subordinate commanders identified for decentralized execution as “front line decision makers (such as strike package leaders, air battle managers, forward air controllers).”[32] The *Air Force Basic Doctrine* vignette-styled explanation of decentralized versus centralized execution allows for individual planning details for a “sortie leader” but makes no allowances to creation of sorties beneath the JFACC level.[33] It is clear that Air Force doctrine relegates decentralized execution to operators conducting missions at the tactical level only. Air doctrine does not explicitly mention and avoids any definitions that allow for actions by subordinate commanders between the JFACC and tactical leader. Ultimately, Joint and Air Force doctrine centralizes the operational level of warfare for airpower at the JFACC level with no allowance for execution by subordinate commanders.

[30] Air Force Doctrine Volume 1, *Air Force Basic Doctrine*, 68.
[31] Air Force Doctrine Volume 1, *Air Force Basic Doctrine,* 69.
[32] Air Force Doctrine Volume 1, *Air Force Basic Doctrine,* 69.
[33] Air Force Doctrine Volume 1, *Air Force Basic Doctrine,* 68.

Chapter 2

Evolution of Centralized Control of Airpower

The evolution of centralized control in a single airman is the result of over 100 years of aviation and combat history. The Air Force's master tenet of centralized control, decentralized execution is reflective of this history and the lessons learned in combat.[1] However, the Air Force struggled to institutionalize these lessons as technology and service parochialism prevented implementation. By 1991, centralized command and control of airpower finally came into fruition with the decisive defeat of the Iraqi Army. Nonetheless, the current institutional vector for command and control of airpower, built on historical baggage and decreasingly valid assumptions, may not provide the best course of action to ensure effective command and control of airpower in future conflicts.

WWI and WWII – First Contact with Centralization

In the earliest days of using airpower in combat, airmen recognized the value of centralized command under a single airman in order to ensure unity of effort. During World War I, the nascent technology of combat aviation was divided by then-Col. Billy Mitchell into tactical and strategic aviation.[2] This early division of aviation not only allowed focus of efforts on disparate mission sets, but it also became a lasting hurdle to centralization of command in the future. Although tactical aviation found increased effectiveness and proven combat success through

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[1] Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?,* Research Paper 2009-1 (Maxwell AFB, AL: Air University Press, 2009), 1.
[2] Col. Billy Mitchell's *General Principles Underlying the Use of the Air Service in the Zone of Advance A.E.F.* defines the two general classes as tactical and strategical aviation. The author annotated the term strategical as strategic here to match contemporary terminology. Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force 1907-1960. Volume I* (Maxwell AFB, AL: Air University Press, 1989), 22.

centralization, strategic aviation received a much greater focus after the war.

During WWI, the primary purpose of tactical aviation was as attached artillery spotters and observation for fielded ground units.[3] In order to increase the effectiveness of airpower, the French first began centralization of its tactical air force, that is fighters and light bombers, with the creation of the Aerial Division in 1918.[4] The centralization of airpower in WWI reached its zenith in the battle for the St Mihiel salient. Col. Mitchell consolidated over 1,400 aircraft, one-third of which were American, into a single attack plan that helped destroy the German salient and win the day for the allies.[5] Tactical aviation had proven successful when operating under a single airman. The first part of the master tenet, centralized control, was taking shape.

Although Col. Mitchell's centralization of tactical aviation at St. Mihiel was a long march, American and British commanders held strategic air forces completely separate and centrally controlled from the beginning.[6] This centralization was rooted in the promise that heavy bombing would break the will of the enemy, a belief embodied in both early theory and writing on the subject of airpower.[7] The thinking behind this theory was that centralization of strategic bombing air forces would create mass which would in turn provide the damage needed to destroy the morale of the enemy and end the war. Although this theory failed in the First World War, it dominated interwar thinking on combat aviation.

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[3] Futrell, *Ideas, Concepts, Doctrine Volume I*, 24.
[4] John Andreas Olsen, *A History of Air Warfare* (Washington, DC: Potomac Books, 2010), 21.
[5] Futrell, *Ideas, Concepts, Doctrine Volume I*, 22; Olsen, *A History of Air Warfare*, 21; Lee Kennett, *The First Air War: 1914-1918* (New York: The Free Press, 1991), 215.
[6] Billy Mitchell had to overcome the widely accepted norm that airpower was attached to ground units in order to enable a centralized effort. Futrell, *Ideas, Concepts, Doctrine Volume I,* 22-23.
[7] This includes period fiction on airpower, most notably H.G. Wells' novel *The War in the Air.*

During the interwar period, the Allies partially adopted the lessons from the First World War. The United States primarily focused on centralization of airpower on strategic bombing and tactical aviation fell to dispersed control among separate army units. Despite post-war estimates that strategic airpower was unable to achieve the level of destruction necessary to force capitulation, the United States and United Kingdom continued their strategic focus.[8] Air theorists such as Giulio Douhet popularized the doctrine of independent and centralized strategic bombing.[9] The lessons Col Mitchell learned at St Mihiel for tactical aviation were largely lost. The division that Col Mitchell had created between strategic and tactical forces also served as an organizational wall that limited the effort of centralization despite the lessons learned.

The strategic focus of the interwar period resulted in early failure of tactical combat aviation in World War II. Allied commanders dispersed tactical air power among the fielded army units in North Africa. Unsurprisingly, the German adversaries consistently outperformed their Allied counterparts. Reflecting on his experiences in Tunisia, General Bernard L. Montgomery laid the foundation for doctrinal centralization of airpower in his pamphlet *Some Notes on High Command in War.* According to Montgomery, "Nothing could be more fatal to successful results than to dissipate the air resources into small packets placed under command of army formation commanders, with each packet working on its own plan."[10] General Montgomery provided the legitimacy necessary to invalidate the "small packets," or decentralized control approach to aviation, as a successful air strategy.

The impact of General Montgomery's pamphlet was immediate. Maj Gen Carl Spaatz centralized control of the Northwest Africa Allied Air

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[8] Kennett, *The First Air War*, 221.
[9] Giulio Douhet, *The Command of the Air,* ed. Joseph Patrick Harahan and Richard H. Kohn (Tuscaloosa, AL: University of Alabama Press, 2009), 35.
[10] Futrell, *Ideas, Concepts, Doctrine Volume I*, 137.

Forces as the Air Corps wrote new doctrine back in the states in a mere three weeks.[11] *War Department Field Manual FM 100-20 Command and Employment of Air Power* now fully codified centralization of air power in doctrine (bold author's emphasis):

> **COMMAND OF AIR POWER**. – The inherent flexibility of air power, is its greatest asset. This flexibility makes it possible to employ the whole weight of the available air power against selected areas in turn; such concentrated use of the air striking force is a battle winning factor of the first importance. **Control of available air power must be centralized and command must be exercised through the air force commander if this inherent flexibility and ability to deliver a decisive blow are to be fully exploited**.[12]

By 1943, the Army Air Corps had intellectually fully realized the impact of centralized control. However, two major elements continued to limit centralization of command and control during World War II: intraservice requirements and technology. As tactical aircraft sought objectives to ensure battlefield dominance, the strategic bomber force focused primarily on eliminating industrial capacity of the Axis nations. Although there were opportunities for strategic bombers to directly impact the tactical battlefield, such as the bombing preparations for D-Day, it was not the norm. Army Air Corps leaders debated the idea of removing the distinction between tactical and strategic air forces. However, the requirement to support ground forces concerned General Hap Arnold and he wanted to ensure the freedom of action for strategic forces. As a result, based largely on intraservice requirements of the United States Army, the Air Force maintained the distinction and the Air Forces remained bifurcated.[13]

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[11] Futrell, *Ideas, Concepts, Doctrine Volume I*, 137.
[12] War Department Field Manual (FM) 100-20, *Command and Employment of Air Power,* 21 July 1943, 4.
[13] Futrell, *Ideas, Concepts, Doctrine Volume I*, 137.

Technology also played a major influence in preventing further centralization by limiting the depth of command available to Air Force commanders in World War II. Aircraft combat radius, radio line of sight capability, and flying time for physical correspondence limited the ability to coordinate among geographically-separated units.[14] The span of control necessary during World War II, ranging across the globe, made centralized control almost impossible. As a result, the Air Force divided its forces into geographically manageable chunks represented by the numbered Air Forces. Although separate numbered Air Forces may have accomplished similar objectives by similar means, such as Eighth Air Force in the United Kingdom and the Fifteenth Air Force in Italy, technological limitations prevented centralizing them under a single command and control system early in the war. However, by coordinating broad objectives each numbered Air Force was operating under a singular air strategy developed by the allies by war's end. [15]

Korea and Vietnam – The Interservice Hurdle

After World War II, airmen cemented the concept of centralized control for the Air Force in order to maximize unity of effort and flexibility. Technology continued to limit the depth of command available, particularly over large geographic distances. However, with the creation of the United States Air Force in 1947, intraservice rivalry gave way to interservice rivalry. The old concern of separating tactical and strategic

[14] Physical correspondence in this monograph includes any non-electronic form of communication such as physical transportation of planners or plans. The Air Force still utilized this as a primary form of communication during the First Gulf War between air planners and deployed units as C-21 aircraft delivered air tasking orders throughout the theater. Richard G. Davis, *On Target: Organizing and Executing the Strategic Air Campaign Against Iraq* (Honolulu, HI: University Press of the Pacific, 2005), 93.
[15] Both Eighth and Fifteenth Air Force were under US Strategic Air Forces in Europe by 1944. The strategic air commander controlled the strategic air campaign except during Operation Overlord when he handed over planning, targeting, and apportionment to General Eisenhower. The Air Force maintained the numbered Air Force arrangement even under a single strategic air commander for US forces and many airmen argued that it made coordination for support difficult. Futrell, *Ideas, Concepts, Doctrine Volume I,* 150.

forces in order to ensure the flexibility of strategic aviation while meeting the need for tactical support of ground troops continued in its new interservice form. In addition, Naval aviation added a new element to the interservice problem. Although the Army Air Corps and Naval aviation interacted during World War II, the scope of the war allowed for concentration by a service in a particular area of operations. Conversely, in both the Korean and Vietnam conflicts, the relatively smaller geographic scale ensured that the services would be conducting concurrent operations over the same area. As airmen continued to pursue centralization of airpower after World War II, interservice parochialism provided a new impediment that continues to drive the command and control doctrine today.

In Korea, General Douglas MacArthur referred to the commander of the Far East Air Forces (FEAF or all Air Forces operating in the area of operations that included Korea, Japan, Guam, and the Philippines) as the "over-all air commander."[16] As a result, the FEAF commander, Lt Gen George E. Stratemeyer, requested that Marine and Naval aviation be placed under his operational control.[17] However, despite the lofty title of "over-all air commander," no such authorities accompanied the title, and instead Gen Stratemeyer received "coordination control," a previously undefined authority.[18] Interservice parochialism had trumped centralized control of airpower, the primary airpower lesson gleaned from combat during World War I and II.

Lacking depth of command outside of the tactical Air Force, FEAF attempted to coordinate airpower across the services by requesting Marine and Naval aviation liaison officers to join the FEAF Formal Target

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[16] Robert F. Futrell, *Air Operations in the Korean War: 1950-1053,* USAF Historical Division Liaison Offices (Maxwell AFB, AL: USAF Historical Division, Air University, 1961), 11.
[17] Futrell, *Air Operations in the Korean War,* 11.
[18] Futrell, *Air Operations in the Korean War,* 11.

Committee and joint operations center in Korea.[19] Although the early elements of centralized coordination were in place, technology severely limited the ability to communicate with naval air units. As a result, air planners divided the battlefield into separate areas of operations for the individual services.[20] By the last month of the war, a teletype allowed communication between the joint operations center and naval units, increasing coordination between the separated operational areas. Although technological limitations along with interservice parochialism were still major factors in limiting centralization, technology also began to provide a solution to commanders.

The final recommendation on air-ground operations in Korea was that "in future hostilities there should be a definitive requirement for 'integration of all services in a manner similar to that accomplished in the last month of the Korean War'."[21] In *Air Operations in the Korean War: 1950-1953*, Dr. Robert Futrell aptly summarizes the most important air lessons from Korea when he writes, "the greatest single weakness of the organization in the Far East was a lack of unified control and direction of all available airpower. The Korean experience should have made clear that airpower ought not to be compartmented or divided."[22]

Despite these lessons, both the Korean and Vietnam conflicts kept the command and control of the strategic bomber force distinctly separated from tactical aviation as had been done since World War I. Although strategic bombers played a critical role in the tactical battlefield situation for both conflicts, Air Force leaders did not allow aircraft designated as strategic assets to fall under the command of theater airmen in Vietnam. Even as B-52 Arc Light missions became commonplace and provided on-call close air support to ground

[19] Futrell, *Air Operations in the Korean War,* 12.
[20] Futrell, *Air Operations in the Korean War*, 13.
[21] Futrell, *Air Operations in the Korean War*, 14.
[22] Futrell, *Air Operations in the Korean War*, 46.

commanders in Vietnam, Strategic Air Command (SAC) maintained the command and control relationship and coordinated with Pacific Air Forces (PACAF) and Pacific Fleet (PACFLT).[23] The intraservice rivalries of the World Wars that separated tactical and strategic aviation continued to have an impact manifested as interservice mistrust in Korea and Vietnam. Service priorities and infighting would once again become a major hurdle to increasing depth of command for a single air commander as it had in Korea.

Just as interservice rivalries during the Vietnam conflict maintained the barrier between strategic and tactical air, service parochialism and technological communication limitations continued to work in unison to prevent the potential for centralization across the services. Although technological advances and proliferation of modern radios greatly advanced the ability to communicate over distances, the depth of command of tactical air power in Vietnam was still heavily limited early in the conflict. Unlike air forces in Korea commanded from nearby Japan, tactical aircraft in Vietnam were under the command of the Pacific Air Forces (PACAF) stationed over six thousand miles away in Hawaii.

Recognizing the limitations of this arrangement and the need to improve communications with aircraft and ground forces in theater, PACAF stood up the 2nd Air Division in Vietnam in 1961 to "supervise and coordinate USAF operational activities" out of Saigon.[24] In 1964, the 2nd Air Division took control of air advisory forces as well as operational forces, and for the first time all Air Force assets in South Vietnam were under a single operational command and control. By the end of 1965,

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[23] CHECO (Contemporary Historical Evaluation of Combat Operations) Division, Directorate, Tactical Evaluation, PACAF. *Command and Control 1965*, Staff Study, 15 December 1966, 2. Document is now declassified.
[24] Corona Harvest, Designated Study #7, *Volume II: Command and Control* (Maxwell AFB, AL: Air University, 15 December 1967), 3-4. Document is now declassified..

with the increasing proliferation of "USAF tactical, communications, administrative, and logistical units," the 2nd Air Division was redesignated as PACAF Seventh Air Force controlling approximately 1100 combat aircraft.[25] The numbered Air Force solution that worked to geographically separate centralization in World War II was once again at work in Vietnam.

As the Air Force centralized control of its tactical aviation, PACAF still shared a command and control relationship for operational employment with PACFLT commanders. Predictably, infighting among the separate services ensued. PACAF and PACFLT staffs geographically divided Navy and Air Force aircraft in order to deconflict air strikes in North Vietnam.[26] Airmen referred to this geographical division of control as the now-infamous "route packages."[27] This system of control was a compromise for not placing theater airpower under a single operational authority and "prevented a unified, concentrated air effort."[28] It was also a realization of the technological limitations of the time for coordinating a large force by a single air commander. Unfortunately, by fragmenting air forces, the route package system created allocation problems that were not flexible to meet the changing tactical requirements.[29] Ultimately, the route package system provide a viable solution to interservice rivalry and technological limitations while still highlighting the costs of not centralizing airpower under a single airman.

Meanwhile, in South Vietnam, Air Force leaders argued that the Marine Corps Marine Air Wing (MAW) Commander did not sufficiently

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[25] Corona Harvest, *Volume II: Command and Control*, 4; General William W. Momyer, *Airpower in Three Wars (WWII, Korea, Vietnam)* (Maxwell AFB, AL: Air University Press, 2003)*, 95.*
[26] Momyer, *Airpower in Three Wars*, 104.
[27] Momyer, *Airpower in Three Wars*, 104.
[28] Momyer, *Airpower in Three Wars*, 108.
[29] General Momyer addresses numerous tactical failures of the route package system including failure to provide localized twenty-four hour coverage, excessive assets in route packages resulting in waste, and inability to flex effectively for changes to weather. Momyer, *Airpower in Three Wars, 106.*

provide for operational control of Marine aircraft sorties for air defense and failed to coordinate strikes with PACAF.[30] According to the Air Force and General Westmoreland, commander of all United States military operations in Vietnam, the Marines air-ground team doctrine "resulted in lack of air support for other than Marine forces."[31] Alternatively, MAW leadership found the Air Force "intransigent and hard to deal with."[32] In December of 1965, under direction from Gen Westmoreland, Air Force leadership in Vietnam prepared "justification and operating procedures" to place Marine aviation under Air Force control.[33] The Commander in Chief, PACAF (CINCPACAF), ordered a halt to these plans because of "[Joint Chiefs of Staff (JCS)] sensitivity to interservice bickering."[34] Placing Marine aviation under Air Force control is a point of contention between the services that continues today.

Learning from the lessons in South Vietnam and the loss of effectiveness from the route package system, the Air Force attempted unsuccessfully to coordinate airpower from the Navy and Marine Corps in a centralized manner. During Operation ROLLING THUNDER, PACAF requested operational control of Navy aircraft striking targets in North Vietnam or Laos, including selection of targets, timing, coordination, and allocation.[35] CINCPACFLT disagreed, stating that naval airpower could not be separated, as it was an inherent part of the fleet.[36] CINCPAC concurred, and control of airpower continued fragmented between the services.

Even as early as 1967, the Air Force concluded that the "most significant conclusion that can be drawn from tracking the evolution of

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[30] CHECO, *Command and Control 1965*, 29.
[31] CHECO, *Command and Control 1965*, 29.
[32] CHECO, *Command and Control 1965*, 29.
[33] CHECO, *Command and Control 1965*, 29.
[34] CHECO, *Command and Control 1965*, 30.
[35] Momyer, *Airpower in Three Wars*, 90.
[36] Momyer, *Airpower in Three Wars*, 102.

the command and control structure in South Vietnam is that, in spite of advanced technology and a scientific approach to management, the U.S. allows itself to forget or disregard such elementary principles as unity of command."[37] The Air Force had now concluded in two separate conflicts, Korea and Vietnam, that all airpower, regardless of service, should be under a single command and control authority in order to be most effective. Despite technological solutions that made a unified air component commander increasingly possible, parochial service interests prevented this from happening. Vietnam set the stage for creating a single air commander in the Gulf War as well as providing the most modern example of large-scale conflict without centralized control. As a result, Vietnam is valuable for both its lessons in the value of centralization and the relevant combat lessons on decentralization.

The Gulf War – Centralized Control and the First JFACC

The negative impact of service parochialism on combat capability was not lost on the United States Congress. The Goldwater-Nichols Department of Defense Reorganization Act of 1986 attempted to eliminate the service parochialism and rivalry so prevalent in military operations in Vietnam and Grenada. This Act redefined the chain of command from the president through the combatant commanders and prioritized joint concepts for warfare in an attempt to overcome the service rivalries. As a direct result, the 1986 *Joint Doctrine for Theater Counterair Operations* allowed for the Joint Force Commander (JFC) to designate a Joint Force Air Component Commander (JFACC) whose "responsibilities will be assigned by the joint force commander (normally these would include, but not be limited to, planning, coordination, allocation and tasking based on the Joint Force Commander's apportionment decision). Normally, the joint force air component commander will be the Service component commander who has the

[37] Corona Harvest, *Command and Control,* 6.

preponderance of air assets and the ability to assume that responsibility."[38] Despite some nuanced consideration toward the command of Marine aviation, the Air Force finally had a doctrinal solution to centralized control across all of the services 43 years after North Africa and FM 100-20.[39]

The Gulf War was the first opportunity to test centralized airpower across all of the services in combat and under the command authority of the JFACC. Lt Gen Charles A. Horner, the US-led alliance's designated air component commander, was well aware of the challenges presented by both the other services and coalition partners and his need to overcome lingering resistance to centralization of airpower C2. One of the primary methods that Gen Horner used to solidify the JFACCs authority was the Air Tasking Order (ATO).[40] The ATO originally tasked air assets with the defense of Saudi Arabian airspace but Horner expanded the scope to coordinate all theater air missions. According to Horner, "the need for a daily ATO established the Joint Force Air Component Commander…Without the ATO, you don't have the JFACC. With the ATO you don't have anything but a JFACC."[41] The primacy of the ATO process was established, and the JFACC had finally centralized theater airpower.

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[38] The 1986 *Joint Doctrine for Theater Counterair Operations* and Joint Chief of Staff Publication 12 reaffirmed the 1986 omnibus agreement which allowed for the JFC to apportion Marine aviation assets while at the same time reaffirmed that the primary mission of Marine fixed-wing aviation was counter land operations. The same verbiage regarding tasking of Marine aviation in the 1986 Joint doctrine is found today in Joint Publication 3-30, *Command and Control of Air Operations*, Chapter II section 4e. Ultimately, although Marine aviation is recognized as organic to Marine ground forces, the JFC determines apportionment of air assets. Joint Publication (JP) 3-01.2, *Joint Doctrine for Theater Counterair Operations,* 1 April 1986, III-4; Mark D. Mandeles, Thomas C. Hone, and Sanford S. Terry, *Managing "Command and Control" in the Persian Gulf War* (London: Praeger, 1996), 128.

[39] JP 3-01.2, *Joint Doctrine for Theater Counterair Operations,* III-4; Richard Davis, *On Target: Organizing and Executing the Strategic Air Campaign Against Iraq* (Honolulu, HI: University Press of the Pacific, 2005), 35.

[40] Mandeles et al., *Managing "Command and Control",* 129.

[41] Mandeles et al., *Managing "Command and Control",* 129.

The development of an ATO that coordinated over 3,000 air sorties a day required a tremendous amount of effort.[42] In order to accomplish this feat, as well as assess and plan the conduct of future operations, Gen Horner reorganized personnel and created the predecessor to the modern Air Operations Center (AOC). Gen Horner's reorganization brought together the tactical air control center (TACC) for execution of daily operations with combat planning personnel from Col. John Warden's now famous Checkmate planners.[43] The reorganization allowed synchronization of efforts and provided Gen Horner with the organizational ability to achieve depth of command. Advances in technology provided Gen Horner the minimum communicative capability required to effectively plan and conduct operations from a central location. On 20 February 1991, a little over a month after the start of the air campaign, the TACC had a full air picture with data combined from Air Force and Navy airborne radars.[44] For the first time, technology had empowered centralization of air power instead of limiting it.

Finally, the 1991 Gulf War provided combat proof to airmen that unity of effort in airpower through centralized control provided the decisive element of victory.[45] One of the lessons that the Air Force recognized after the Gulf War was that interservice rivalry was a greater threat to centralized control, and thus airpower, than the enemy. When Navy commanders, concerned that terrorism or a ballistic missile attack on the air headquarters could eliminate Gen Horner's physical capability to conduct the air campaign, suggested adopting a "route package" system similar to the one utilized in Vietnam, Horner adamantly opposed it.[46] Gen Horner feared loss of control as the JFACC from division of Navy

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[42] Mandeles et al., *Managing "Command and Control",* 137.
[43] Davis, *On Target,* 34; Mandeles et al., *Managing "Command and Control",* 26.
[44] Mandeles et al., *Managing "Command and Control",* 142.
[45] Deputy Chief of Staff, Plans and Operations Headquarters, United States Air Force, *JFACC Primer,* 10 January 1994, 12.
[46] Mandeles et al., *Managing "Command and Control",* 129.

and Air Force assets much more than the enemy's ability to disrupt centralized control. This is a service institutional fear that continues to impact decisions today.

A second lesson embraced by airmen after the Gulf War was the need to create and maintain an organizational solution for the centralization of airpower. One of the criticisms of Gen. Horner's performance is that he relied on his strength of personality and political skills more than "a reliable, resilient process" to institutionalize the role of the JFACC.[47] The Air Force recognized that the best way to ensure that an airman controlled airpower was to develop an organizational solution, built on technology, which enabled theater wide command and control. The organizational product that had ensured this during the Gulf War was the ATO.[48] The organizational method, the reorganized headquarters built around the TACC, developed into the modern AOC.

Post-Gulf War – Uncontested Centralization

Command and control of airpower and the AOC developed after the Gulf War in a very specific environment shaped by the fall of the Soviet Union, conflicts against adversaries with limited capabilities, and the dawn of the information age. The 1990s was the height of American hegemony, and as such, few adversaries could contest US dominance. This was particularly true in the information domain on which the United States was becoming increasingly dependent. During this peak, the United States also began a consistent drawdown in forces, further driving both weapon system and personnel reductions.[49] The impact was

[47] Mandeles et al., *Managing "Command and Control",* 144.
[48] Even after the Gulf War, Navy and Marine leaders questioned the flexibility of an ATO approach to a more capable enemy. James P. Coyne, *Airpower in the Gulf*, (Arlington, VA: Air Force Association, 1992), 156.
[49] Eric Larson, David T. Orletsky, and Kristin Leuschner. *Defense Planning in a Decade of Change: Lessons from the Base Force, Bottom-Up Review, and Quadrennial Defense Review*. (Santa Monica, CA: RAND, 2001) 17-39.

an assumption that centralized command and control was not only more effective, but it also provided an efficiency alternative to large staffs.

Technological advances enabled the centralization of air power throughout history. The space and cyber domain offered particularly effective means to execute command and control of physically disassociated forces. New concepts such as network centric warfare only furthered the ability for centralization and depth of command for the JFACC. The collective opponents America faced since Vietnam could not challenge the Air Force in the space or cyber domain. As such, command and control moved forward under the assumption that these domains provided a sanctuary for operations.

As the AOC proved successful by providing an increasing capability for depth of command, subordinate commanders lost command and control capability and staffs to personnel reductions.[50] One example of this is the air division. Subordinate to numbered Air Forces, air divisions provided command and control for multiple wings as designated by their parent command. Utilized heavily in Vietnam and the again during the Gulf War, air divisions provided a subordinate command and control capability to the JFACC.[51] Often provisional during wartime, air divisions provided subordinate commanders the resources to execute operational control (OPCON) over forces. Despite the use of four provisional air divisions in the Gulf War, the Air Force discontinued use of air divisions in 1992.[52] Reduction of command and control capability outside of the

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[50] By the time of the Gulf War personnel reductions of up to 20-40% had already begun. The U.S. military posture was changing from its Cold War strategy of "forward defense" to a new posture of "forward presence." The Air Force structured these forces to be light and mobile, often making up for deeper than expected personnel cuts by "streamlining headquarters" in order to maintain operators in cockpits. Larson et al, *Defense Planning in a Decade of Change,* 17-39, 76-77, 103.

[51] Corona Harvest, *Command and Control,* 3-4.; Mandeles et al., *Managing "Command and Control",* 23.

[52] The Air Force had four provisional air divisions in the Gulf War. The 14th included fighters, the 15th performed command and control as well as reconnaissance and

AOC was of minimal risk for the Air Force based on the assumption that command and control was now centralized and operated in relative sanctuary from enemy disruption.

The desire to achieve centralization of airpower is rooted in history across the entire spectrum of warfare. The impact has been undeniable and highlighted by contemporary successes during the 1991 Gulf War as well as the 2002 Taliban defeat in Afghanistan and the 2003 invasion of Iraq. Technological advancement and doctrinal development forced by civilian intervention mitigated the initial limitations of technology and interservice rivalry to provide a single component commander the depth of command necessary to execute control of air operations across any theater of operations.

Singular command depth, exemplified in the AOC, maintains an assumption of supremacy across the air, space, and cyber domains. The last time an adversary significantly contested the air domain was World War II, and the United States has never faced an enemy capable of contesting the space or cyber domain credibly. The future of command and control will most likely challenge both the long-held belief in the resilience of technology and that interservice rivalry is the greatest threat to centralized control of airpower. Recognizing these assumptions, the institutional impact of their associated history, and lessons in command of airpower from the past will help provide solutions for the next challenge.

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electronic warfare, the 17th was primarily strategic assets, and the 1610th was an airlift division. Mandeles et al., *Managing "Command and Control",* 23.

Chapter 3

The New Airpower Achilles Heel

Lessons learned during the development of airpower and its integration into the modern battlefield supported centralized command of air assets as technology gradually enabled increasingly centralized control by senior commanders. [1] After successful centralization during the 1991 Gulf War, the Air Force sought to minimize control outside of a JFACC, strengthening the role of the AOC in both planning and conducting joint campaigns. The unfortunate side effect of this centralization is the potential for single nodal failure in the command and control of airpower.

The AOC pulled resources from subordinate commanders as both doctrine and increasingly strict rules of engagement limited the operational authority of leadership outside of the JFACC. With the loss of resources and shrinking authorities, the height of execution for subordinate commanders at the operational level diminished. The result was that centralization through the JFACC-led AOC doctrinal construct provides a capable adversary the opportunity to "degrade, disable, or overwhelm our systems and networks inhibiting the [JFACC's] ability to efficiently [command and control], resulting in loss of operational effectiveness."[2] In order to minimize strategic impact from disruption, the

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[1] This term airpower Achilles heel is "new" concerning the amount of risk posed to centralized nodes for conventional operations. Paul Baran utilized the term "Achilles heel" to define the problem with centralization of nuclear command and control systems as early as 1960. Paul Baran, *On A Distributed Command and Control System Configuration,* U.S. Air Force Project RAND Research Memorandum, December 31, 1960, 9.

[2] PACAF A3/6C, "C2 in a Contested Environment", Briefing at USAF Command and Control Summit, January 2015, slide 2.

command and control of air component forces must have resiliency, or an ability to "bounce back" during adversary initiated actions.[3]

Centralization and the Operational Level of War Problem

The greatest impact that centralization has had on airpower is at the operational level. Joint Publications define the operational level of war as follows: "The level of war at which campaigns and major operations are planned, conducted, and sustained to achieve strategic objectives within theaters or other operational areas."[4] The focus at the operational level "is on the planning and execution of operations using operational art: the cognitive approach by commanders and staffs" to link tactics and strategy.[5]

The operational level for airpower, as driven by Air Force doctrine, resides primarily with the JFACC.[6] The organizational solution to centralized command and control is the AOC.[7] As defined by Air Force Instruction, the AOC provides the organizational construct necessary to provide "operational-level C2 of air, space, and cyberspace operations."[8] In order to achieve this, Air Force doctrine prescribes a five-division concept for the AOC: Strategy; Combat Plans; Combat Operations;

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[3] This definition of resiliency utilizes Mark Pflanz and Alexander Levis' short definition in "An Approach to Evaluating Resiliency in Command and Control Architectures" and the concept of adversary initiation from *Understanding Command and Control*. Mark Pflanz and Alexander Levis, "An Approach to Evaluating Resiliency in Command and Control Architectures", New Challenges in Systems Engineering and Architecture Conference Paper, Organized by Missouri University of Science and Technology, 2012; David S. Alberts and Richard E. Hayes, *Understanding Command and Control* (Washington D.C.: Command and Control Research Program [CCRP], 2006), 187.
[4] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 8 November 2010, as amended through 15 January 2015, 182.
[5] Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States*, 25 March 2013, I-8.
[6] Air Force Doctrine Volume 1, *Air Force Basic Doctrine*, 27 February 2015, 67
[7] Air Force Doctrine Volume 4, *Air Force Operations Doctrine*, 5 June 2013, 17; Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.AOC, *Operational Employment: Air Operations Center,* 31 January 2014, 1-1; Air Force Instruction (AFI) 13-1AOC, Volume 3, *Operational Procedures – Air Operations Center (AOC),* 2 November 2011, 1.1.2.
[8] AFI 13-1AOCV3, *Operational Procedures,* 2.1.

Intelligence, Surveillance, and Reconnaissance; and Air Mobility.[9] Teams further subdivide the divisions into task specific groups that provide a JFACC the flexibility to configure according to mission requirements.

The Air Tasking Cycle represents the operational command and control process.[10] The primary product of the Air Tasking Cycle is the Air Tasking Order (ATO). A single ATO typically directs air operations for a 24-hour period.[11] A simplified approach to defining levels of warfare for air operations is to define execution inside of an ATO as tactical and execution of the decision process for actions beyond 24-hours as operational. Justification for this definition derives from the intent of the Air Tasking Cycle when compared to the joint definition of the operational level of war. The Air Tasking Cycle utilizes assessments of previous actions coupled with the campaign plan and JFC objectives to identify and sequence targets and determine asset allocation. The result of this process is the ATO.[12] At any moment, teams on the AOC staff coordinate multiple ATOs up to 96 hours in advance, ensuring that tactical capabilities achieve strategic objectives.[13]

Coordinated by AOC staffs, the Air Tasking Cycle represents the JFACC's OODA Loop process for the conduct of air operations. Intelligence and assessment feedback studied by the AOC staff is how the JFACC *Observes* the operating environment. JFC direction through strategic objectives, guidance, and the existing campaign plan provide the *Orientation* required for making the decisions to adjust or maintain the existing air component of the campaign plan. The ATO is the physical

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[9] AFI 13-1AOCV3, *Operational Procedures,* 2.2.
[10] The author utilizes the term Air Tasking Cycle throughout this monograph in order to maintain consistency with Joint Doctrine. However, this definition encompasses the Air Planning Cycle as defined by AFTTP 3-3.AOC 2.2.1 definitions as well. AFTTP 3-3.AOC, *Operational Employment*, 2-3.
[11] Joint Publication (JP) 3-30, *Command and Control of Joint Air Operations,* 10 February 2014, III-18.
[12] AFTTP 3-3.AOC, *Operational Employment*, 2-3.
[13] JP 3-30, *Command and Control of Joint Air Operations,* III-18.

manifestation of what the JFACC *Decides*. The authority for production of an ATO resides with the JFACC alone. It provides subordinate and coordinated commanders the information necessary to *Act* in pursuit of the tactical effects desired.

Although simple in theory, the Air Tasking Cycle requires extensive manpower with specialized training to provide the JFACC all of the critical facets of the OODA Loop. During the Gulf War, the TACC (predecessor to the modern AOC) required over 2,000 personnel to produce a daily ATO.[14] The number of personnel required to produce an ATO within the AOC construct is primarily dependent on the span of operations and the number of sorties expected. As the number of joint and coalition partners participating increases, so does the complexity for coordination and the requirement for additional personnel. Although computers and networked technology aid personnel today, the AOC has a tremendous task to provide the depth of command required for the JFACC to direct and coordinate every single air asset in theater. The result is an increasingly complex process for monitoring, assessment, planning, and coordination of air operations (see Fig. 3-1).[15]

[14] Mark D. Mandeles, Thomas C. Hone, and Sanford S. Terry, *Managing "Command and Control" in the Persian Gulf War* (London: Praeger, 1996), 137.
[15] JP 3-30, *Command and Control of Joint Air Operations,* figure III-13.

One of the problems discovered during the Gulf War is that there were a limited number of personnel trained on air planning and construction of an ATO. The TACC, typically manned at its peacetime strength of 300 personnel, required a rapid influx of new people to 2,000 total personnel in order to handle the planning process.[16] This occurred again in Kosovo when the 400 personnel AOC had to grow to more than 1,300.[17] The requirement to train these new personnel severely

[16] Mandeles et al., *Managing "Command and Control",* 137.
[17] Department of Defense, *Report to Congress: Kosovo/Operation Allied Force After-Action Report,* 31, January 2000, 45.

hampered their ability to effectively operate and produce an ATO early in operations.[18] Therefore, trained air planners are a critical requirement to conduct the Air Planning Cycle and produce/execute an ATO.

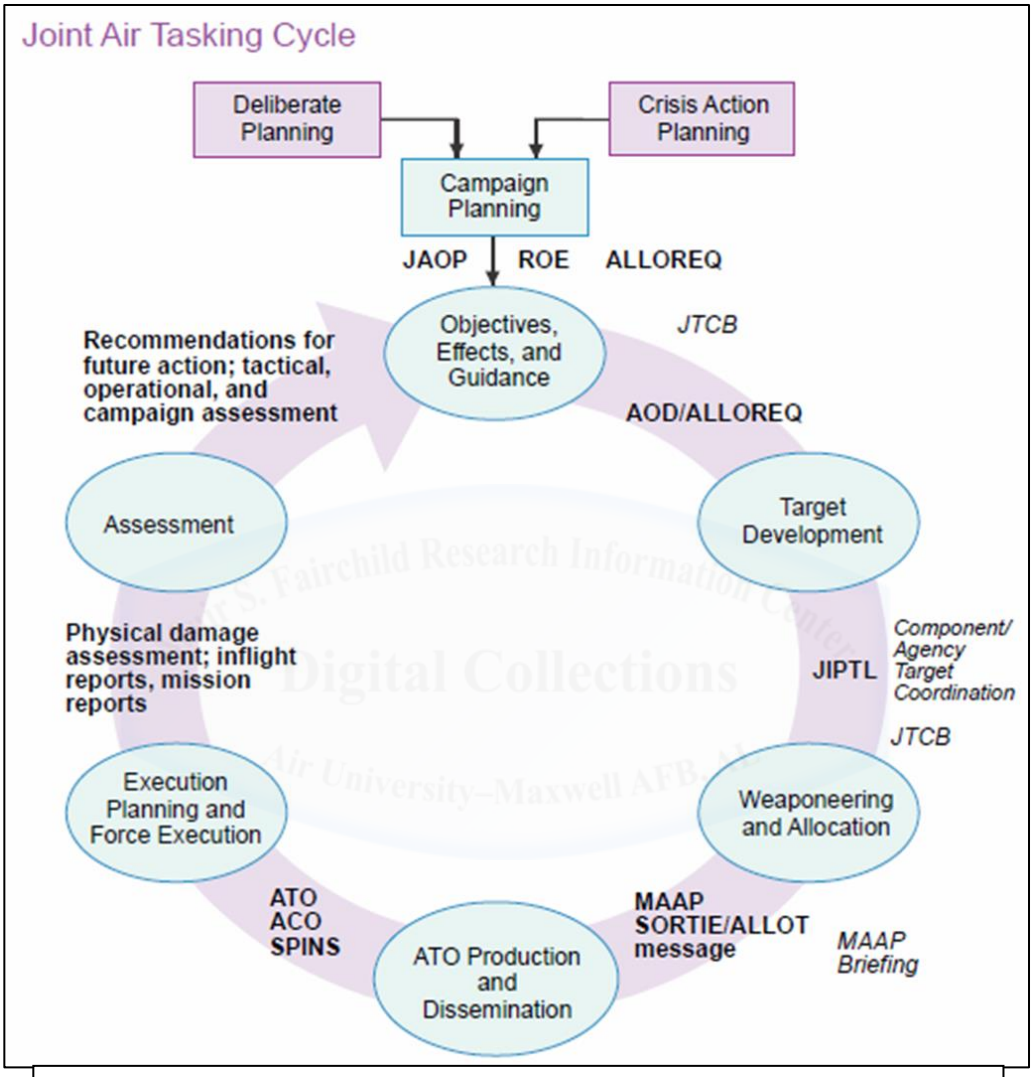

Fig. 3 The Joint Air Tasking Cycle. (Source JP 3-30, *Command and Control of Joint Air Operations*)

Specialized training on AOC operations, including the Air Planning Cycle or ATO development, is not a typical part of an airmen's career progression. Throughout an Air Force operator's early development, introduction to the AOC is limited to the tactical level (i.e., exercises such

[18] Mandeles et al., *Managing "Command and Control,* 137.

as Red Flag and Weapons School single ATO actions). At the operational and strategic levels, in order to fill AOC manning requirements, the Air Force educates tactical leaders on operational conduct of airpower through an AOC school at Hurlburt Field, Florida.[19] Since students typically attend training only when they fill manning billets in existing AOCs, a small portion of the total force receives the specialized training required for effective operational level conduct.

As a result, there is an Air Force-wide dearth of trained personnel capable of execution at the operational level of warfare. The few personnel available fill AOC manning billets, leaving subordinate commanders without personnel qualified or trained to conduct the targeting, planning, and assessment duties required for successful operational level control. This leaves subordinate commanders completely dependent on the AOC for nearly all of their planning requirements.

Effectively, without the dedicated and trained personnel required, subordinate commanders have little to no ability to conduct successful execution at the operational level in the absence of the AOC. Returning to John Boyd's OODA Loop concept, subordinate commanders lack the capacity to conduct operational planning independently. They have a vastly reduced capability to *Observe* through assessment to include theater wide intelligence. *Orientation* to theater objectives and guidance is marginal due to limited daily interaction with the JFACC and the planning staffs. Without trained staffs, there is no capability to *Decide* on conduct of airpower operations because they are unable to perform the required tasks of target development, allocation, and external coordination. Ultimately, subordinate commanders may not even have

[19] The 705th Training Squadron at Hurlburt Field, FL "exists to educate and train AOC senior leaders and staffs of Combatant and numbered Air Force commanders". Source: http://www.505ccw.acc.af.mil/library/factsheets/factsheet.asp?id=15210 accessed 23 Feb, 2015.

the authority required to *Act* outside of a delivered ATO from the JFACC. The OODA Loop beneath the JFACC and AOC level is broken as subordinate commanders have little to no height of execution to conduct airpower operations if disconnected from the centralized command and control node.

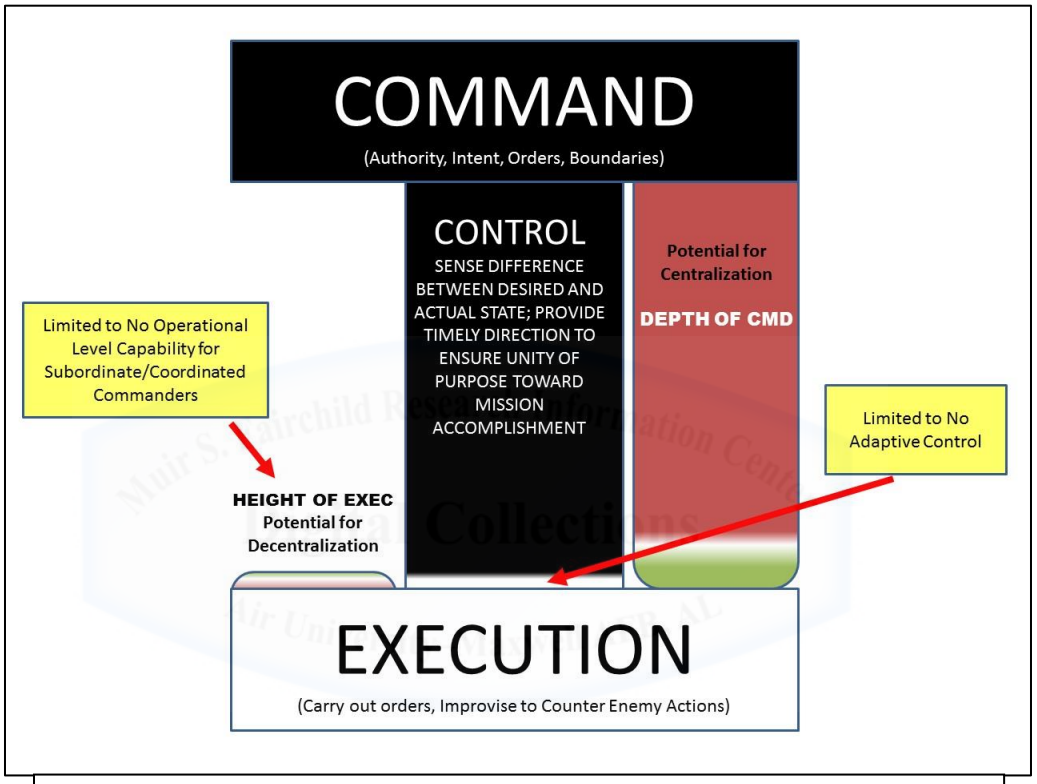

Fig. 4 The C2 Mental Model applied to doctrinal command and control of airpower at the operational level.

Returning to Lt Col Betts' C2 model introduced in the previous chapter provides a visual depiction of the Air Force operational level problem. (see Fig. 3-2)[20]. Under normal peacetime or uncontested conditions, there are no major issues with the conduct of operational level planning. This is because the JFACC's depth of command makes up

[20] The author created this figure utilizing Betts' C2 Mental Model. William Betts, "Airpower's Master Tennent and Anti-Access/Area Denial: Hope Is Not a Course of Action" (Thesis Air War College, Air University, 2014), 6.

for the limited height of execution capability for subordinate commanders. However, this approach leaves no margin of error for disruption by an adversary. Since 1991, the limited capability of adversaries to contest the command and control of airpower, along with increasingly dependable technology allowed this design to operate effectively and become normalized.

However, in the future, a credible adversary may take advantage of the limited ability to conduct airpower operations outside of centralized control. The JFACC, through the AOC, is heavily dependent on beyond line of sight communication capability to provide depth of command. Modern AOCs rely on the space and cyber domains to provide this communicative capability. Since the 1991 Gulf War, multiple adversaries have recognized this vulnerability and developed both kinetic and non-kinetic capabilities to deny or disrupt reliable communication in these domains.[21] Whether through kinetic disruption of a satellite system or non-kinetic denial through cyber, adversaries are increasingly capable of challenging United States information operations.

An adversary that can disrupt the JFACC's centralized control node and thereby reduce the depth of command creates a capability gap (see Fig. 3-3).[22] Because there is no height of execution at the operational level, there is no adaptability in command and control of air forces. Without personnel with the capability or training necessary to *Observe* through intelligence and assessment and limited involvement in higher-

[21] A significant component of China's anti-access/area denial strategy is to control and dominate the information spectrum, "sometimes termed an *information blockade*." China has conducted anti-satellite weapons testing and is continuing to develop multiple counter space and cyber solutions to "disabling US command and control in wartime". Department of Defense, *Annual Report to Congress on Military and Security Developments Involving the People's Republic of China: 2010* (Washington DC: Government Printing Office, 2010), 30. Michael P. Pillsbury, *An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies and Doctrines* (Washington DC: U.S.–China Economic and Security Review Commission, 2007), 14.

[22] The author created this figure utilizing Betts' C2 Mental Model. William Betts, "Airpower's Master Tennent and Anti-Access/Area Denial," 6.

level guidance and planning required to ensure proper *Orientation* of data, subordinate commanders are unable to make informed decisions. Considering the extent of expertise and information required to execute the Air Tasking Cycle, it is inconceivable that under-resourced forward commanders with limited authorities could fill the responsibility/capability gap as a contingency. Through centralization, the Air Force has adopted an "all-or-none" approach to the operational level control of air power. This singular element results in a high level of risk to the effective execution of airpower against a capable adversary in

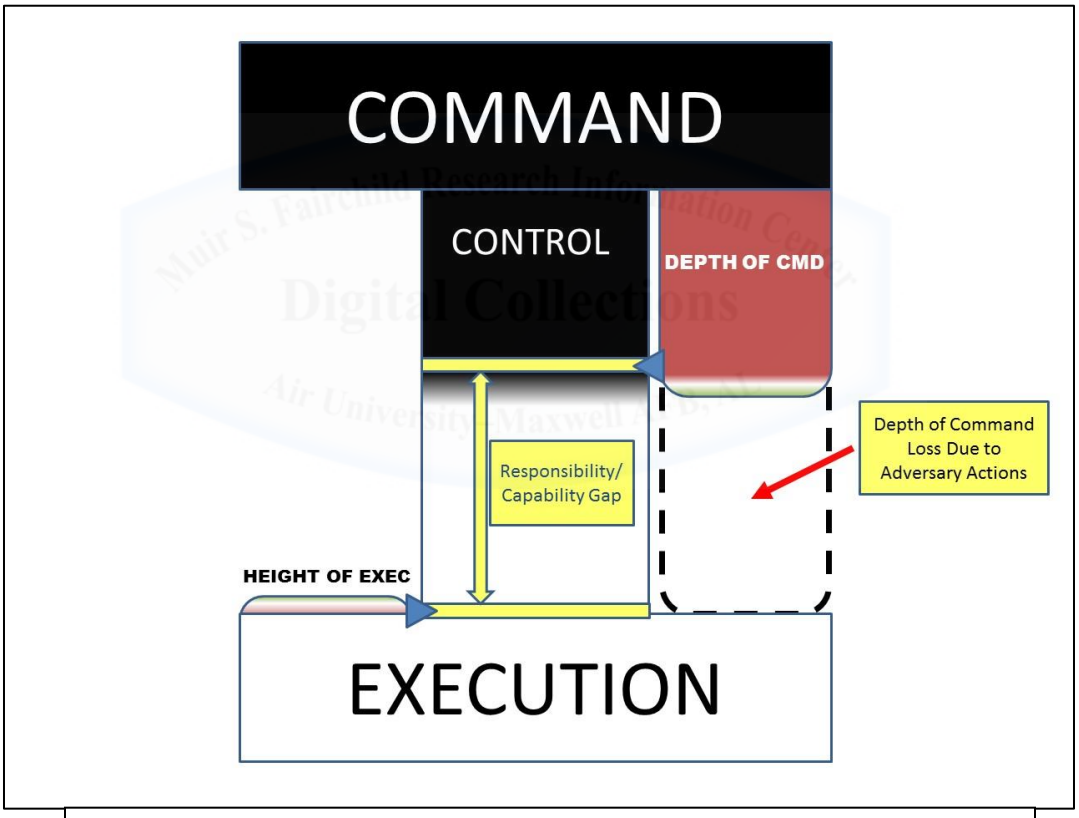

Fig. 5 The C2 Mental Model applied to airpower at the operational level during disruption.

the future.

Cultural Exacerbation of the Problem

Since the 1991 Gulf War, the Air Force has reduced the height of execution for subordinate commanders and inadvertently ingrained a culture that resists change. The Air Force's history of pursuit of centralized control, and its assumption of sanctuary for information operations, has provided institutional incentive to limit commander authority beneath the JFACC. Loss of resources, coupled with limited authority, created a culture that defines commanders as force providers instead of warfighters. Air Force commanders, with marginal responsibility for the conduct of operations, accept this paradigm and provide little motivation for change.

The lingering paradigm left over from the Air Force's hard charge to institutionalize the JFACC after the 1991 Gulf War has left little room for decentralization at the operational level. Decentralization challenges the Air Force's primary combat lesson of unity of effort first codified in FM 100-20. Based on the assumption that the United States will continue to dominate information operations through space and cyber, airmen have developed a doctrine that has slowly squeezed out opportunities for subordinate commanders to make operational decisions. Even as Joint doctrine adopted the mission command concept for decentralization, the Air Force's nuanced approach limited initiative to the tactical level and did not provide opportunities for operational level initiative by subordinate air commanders.[23]

In stark contrast to the USAF's slow calcification around centralized planning processes, the Joint Force's mission command approach provides trust and responsibility in subordinates at all echelons through authorization and the expectation to take the initiative

[23] This approach is nuanced when compared to mission command expectations for land and maritime commanders at all echelons. See Chapter 1 "Command and Control Concepts and Doctrine" section for mission command explanation.

when disconnected from higher authority when fully embraced.[24] Unauthorized to make sortie decisions outside of the ATO and devoid of the personnel required to plan operations, subordinate commanders of airpower are not responsible for operational level planning. Without a warfighting authority at the operational level, the Air Force has relegated commanders beneath the JFACC to administrative control only.[25] The result is that the JFACC and the Air Force charges commanders as force providers only.

Since commanders are responsible and evaluated for administration as force providers, they typically build their staffs around this limited focus. Most operations centers for subordinate commanders concentrate primarily on force protection and sortie generation, having little to no capability to conduct assessment or air planning or track campaign progress.[26] Although AOC's are designed to coordinate across multiple agencies, subordinate air commanders are not resourced in a useful way to provide valuable input into the Air Tasking Cycle outside of tactical mission results.[27] The ATO provides the greatest, if not only, source of understanding of campaign planning to meet strategic objectives. If disconnected from the AOC, commanders are unprepared to meet the strategic and operational objectives with the tactical airpower under their control.

Of course, if the Air Force does not hold commanders responsible for conducting operations outside of centralized control, no one can realistically expect that capability to develop on its own. Conversely, the

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[24] In contrast, despite adopting the ATO system, Navy and Marine leaders see the centralized approach as efficiency at the "cost of operational flexibility." Richard Davis, *On Target: Organizing and Executing the Strategic Air Campaign Against Iraq* (Honolulu, HI: University Press of the Pacific, 2005), 156.
[25] Air Force Doctrine Annex 3-30, *Command and Control*, 7 November 2014, 99.
[26] The author derived this conclusion from his experiences with wing operations centers during contingency operations in PACAF in 2004 (Operation Unified Assistance), Iraq in 2005-2008 (Operation Iraqi Freedom), and Afghanistan in 2010 (Operation Enduring Freedom).
[27] Air Force Doctrine Annex 3-30, *Command and Control*, 42.

Air Force consistently expects its airmen to operate tactically in a decentralized manner. From Red Flag to Weapons School, tactical decentralized execution is a training objective and expected outcome. Large force employment exercises would not allow tactical leaders to operate without a contingency plan on how to conduct operations if disconnected from centralized command and control. Commanders, as force providers, would never accept a weapon system syllabus that did not teach procedures for tactical decentralized execution as a contingency. Yet, commanders accept this every day at the operational level.

The Air Force professional military education program does little more to advance the capability for airmen to execute airpower at the operational level. Air Command and Staff College (ACSC), which offers a Masters of Military Operational Art and Science degree only introduces students to AOC and Air Tasking Cycle processes.[28] Reinforcement of operational planning and processes through practical application exercises is minimal and significantly less than conducted at other service schools.[29] The Air Forces' advanced study course, the School of

[28] Current ACSC syllabus tasks one of eleven courses, Joint Air Operations, with instructing "the important role of the Joint Force Air Component Commander (JFACC), looking at the doctrinal responsibilities of that position, as well as the actors, processes, and products that comprise the [AOC]". Conservatively, 11 hours of total ACSC core instruction are directly attributable to teaching the operational processes of the AOC. In comparison, the formal Joint Air Operations Command and Control Course conducted by the 505th Command and Control Wing, which provides introductory training in AOC operations, is a 13-day course. This intent of this comparison is to understand the difference between formal training baselines necessary for adequate conduct of AOC operational processes and current professional military education syllabi requirements. Command and Staff College, "Joint Air Operations Course Book: AY-15" (Maxwell AFB, AL), 1-8. 505th Command and Control Wing, "Delivering C2 Combat Capability," http://www.505ccw.acc.af.mil/shared/media/document/AFD-131120-062.pdf (accessed 21 May 2015).

[29] Currently, ACSC core curriculum includes two operational planning practicums, one in the Joint Air Operations Course and one in the Joint Campaign Planning Course. The Joint Air Operations practicum is the only exercise that has historically focused on the AOC processes that make up the Air Tasking Cycle. For the ACSC 2014-15 class, leadership chose to change this practicum into "Staff Challenge", tasking students to identify a "major problem/issue/opportunity within an assigned AOR". Including staff challenge, in total, ACSC syllabus provides 17 days (7 days Joint Campaign Planning/10 days Joint Air Operations) for exercise of operational level planning and processes. In contrast, Marine Corps Command and Staff College utilizes forty days for practical exercise of operational planning concepts across all of the joint phases. Air Command and Staff College, "Joint Air Operations Course Book: AY-15" (Maxwell AFB, AL: 2015), 1-8. Air Command and Staff College, "AY15 Joint Campaign Planning Syllabus" (Maxwell

Advanced Air and Space Studies (SAASS), focuses on strategic application of airpower and does not cover operational level processes like the Air Tasking Cycle. Despite the fact that successful conduct of airpower rests on the ability to make decisions based on processes and sub-processes within the Air Tasking Cycle, very few airmen receive adequate training.[30]

However, since the Air Force does not require commanders to be able to conduct operational level processes for airpower, there is no demand signal for this training.[31] Lack of responsibility for commanders to conduct air operations in a decentralized way has entrenched acceptance of minimal height of execution at the operational level. The result is that commanders have no incentive to seek change in the process. Without internal motivation for change, the Air Force is at risk for an external stimulus by a potential adversary to highlight this critical oversight.

Implications for National Security

The combination of these elements, centralized control, loss of operational level resources for commanders, and the force provider culture, have created a critical vulnerability for airpower and therefore national security. The impact of an adversary denying or degrading communication between the AOC and subordinate and coordinated commanders is potentially catastrophic. Forward commanders are currently unauthorized and under-resourced to conduct effective airpower that ties tactical capability to strategic objectives.

AFB, AL: 19 December 2014), 1-15. Air Command and Staff College, "Staff Challenge – AY15 Joint Air Operations (JA)" (Maxwell AFB, AL), 1-8. Marine Corps Command and Staff College, "AY 15 Academic Schedule" (Quantico, VA: 10 April 14).

[30] The author sets the adequate training baseline on the 505th formal course requirements that include a 13-day AOC introductory course and any number of AOC initial qualification training courses, most of which exceed two weeks. 505th Command and Control Wing, "Delivering C2 Combat Capability".

[31] "Commanders" refers to non-JFACC commanders.

This vulnerability provides strong incentives for an adversary to challenge the United States strategic interests by preemptively severing the AOC, thus removing all command and control (C2) capacity from the air component of the Joint Force. Disruption of communication between the AOC and commanders prior to the onset of hostilities breaks down the OODA Loop at a critical moment, one that normally requires quick decision-making and rapid adjustment. The lack of resiliency, forced by zero height of execution capability, provides no room for adaption and ensures that attacking the centralized command and control node will be effective for any adversary with the capability. Unless a solution to providing resiliency in command and control of airpower is developed, the United States asymmetric advantage through airpower could be lost.

A Critical Framework for Evaluating C2 Resiliency

A critical look at the operational problem, along with historical lessons, provides a framework from which to evaluate attempts to provide resiliency in command and control. Proposed solutions for resiliency will best serve the problem by addressing the five components proposed below.

1. **Maximize Centralization:** Centralization under a single airman for unity of effort is the primary operational lesson from the history of command and control of airpower since 1943. Built firmly on historical precedent, an adversary cannot render the primacy of centralized airpower under a single airman as false regardless of capability. Solutions that decentralize without requirements or cannot rapidly return to centralized C2 limit effectiveness and flexibility of airpower.
2. **Eliminate Operational Gaps:** Operational gaps (or capability gaps) are sorties lost over time or minimized effectiveness due to lack of coordination. Operational gaps provide an adversary strategic initiative for action against United States interests. When an

adversary disrupts depth of command, and there is no height of execution, there is an operational gap.

3. **Rapid Employment:** Solutions should minimize long lead times such as deployment of personnel and building of infrastructure. Longer lead times assume that the United States will have the opportunity to either set or determine the onset of hostilities. Developing a time intensive solution based on this assumption provides a capable adversary incentive for preemptive action.
4. **Maximize Theater *Orientation*:** As John Boyd's *Schwerpunkt* of command and control, ensuring an accurate *Orientation* of operational planners maximizes effectiveness of air operations. Insufficient theater Orientation will either require lead-time to develop or result in poor operational decisions.
5. **Resource Stewardship:** Solutions should reflect current budget and resource limitations by not requiring excessive costs, particularly in personnel. The important assumption for this component is that the future fiscal operating environment will be no less austere than it is today.

Chapter 4

Three Operational Concepts for C2 Resiliency

Centralized command and control has allowed American airpower to dominate the battlefield, particularly since the 1991 Gulf War. Reinforced by history and enabled by information technology, the Air Force has allowed centralized control to bottleneck operational capability at the Air Operations Center, providing a strategic weakness for an adversary to exploit. The Air Force, as the lead service in command and control of airpower, is responsible for providing a resilient solution that maximizes airpower effectiveness even when contested by an adversary.

This chapter analyzes three organizational concepts for providing resiliency in command and control: Redundancy, Distributed, and Organic. The framework developed in Chapter 2, built from doctrine, history, and the existing problems, provides the analytical reference to compare the three solutions.

Redundancy

Redundancy is a common approach for creating resiliency in any type of system. The Air Force codified this as a solution in its 2008 doctrine for *Command and Control* (AFDD 2-8). It states, "Redundant C2 systems provide the ability for alternative C2 systems to continue operations in the event of failure or damage to the primary system."[1] By providing additional AOCs as centralized command and control nodes, an air component commander can continue operations if the primary AOC is disrupted. In case of disruption, air doctrine either recommended utilizing alternate AOCs or pre-designated AOCs in another command.[2]

Authorities – Redundancy

[1] Air Force Doctrine Document (AFDD) 2-8, *Command and Control*, 1 June 2007, 79.
[2] AFDD 2-8, *Command and Control*, 79.

Authorities are how the commander sets the level of centralized control in the command and control system.[3] Under the redundancy concept for operations, there is no change in authorities for subordinate commanders during periods of disruption. The JFACC retains complete control as the alternate AOC takes over the operational process from the primary AOC. Returning to Betts' Mental Model, redundancy provides a second path for depth of command if an adversary is able to disrupt the primary. Without contingency authorities, the height of execution remains unchanged.

The AOC - Redundancy

Since redundancy provides alternate AOCs that are a near-mirror image of the primary AOC, and in order to provide a more in depth analysis of the three separate resiliency concepts, this section will expand the discussion on the AOC organization as defined by current doctrine. As stated in Chapter 2, there are five AOC Divisions: Strategy; Combat Plans; Combat Operations; Intelligence, Surveillance, and Reconnaissance; and Air Mobility.[4] In the redundancy concept, an alternate AOC and associated personnel replicates each of these divisions in order to continue the conduct of operations under the control of a single airman.

The Strategy Division (SD) develops, refines, disseminates, and assesses the JFACC's strategy for all of the joint campaign phases.[5] This strategy connects the JFACC's capabilities to the joint force commander's objectives, and the division communicates this through a joint air

[3] For a discussion on how the commander sets the level of control, see Betts Mental Model for C2 discussion in Chapter 1 "Command and Control Concepts and Doctrine."
[4] Air Force Instruction (AFI) 13-1AOC, Volume 3, *Operational Procedures – Air Operations Center (AOC),* 2 November 2011, 2.2
[5] AFI 13-1AOC, Volume 3, *Operational Procedures,* 3.1.

operations plan (JAOP).[6] The Air Tasking Cycle, critical to conducting the JFACC's OODA Loop and developing an ATO, begins with guidance from the strategy division.

While the Strategy Division initiates the ATO process with the JAOP, the Combat Plans Division (CPD) provides the bulk of effort required to produce an ATO. Typically split into four teams, Combat Plans "applies operational art to develop detailed execution plans."[7] The CPD accomplishes this through a Target Effects Team (TET), Master Air Attack Planning (MAAP) Team, C2 Plans Team, and an ATO Production Team.[8] The TET gathers all joint force prioritized targets for a given ATO period in accordance with the JAOP.[9] The MAAP Team then develops this into a "time-phased air, space, and cyberspace operations scheme of maneuver" that the ATO production team publishes.[10] Meanwhile, the C2 Plans Team ensures airspace management, defense, and C2 architecture is capable of supporting the ATO.[11]

Once the ATO is coordinated and published, it is the responsibility of the Combat Operations Division (COD) to monitor the battlefield and coordinate changes to the ATO based on real time mission requirements.[12] While the COD has four primary teams (Offensive Ops Team, Defensive Ops Team, Senior Intelligence Duty Officer Team, and Interface Control Team), it also has highly specialized teams tailored to meet the specific needs of the theater.[13] One example is the Dynamic Targeting Cell, which coordinates across all of the components to conduct quick targeting and effects on dynamic and time sensitive

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[6] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 8 November 2010, as amended through 15 January 2015, 127.
[7] AFI 13-1AOC, Volume 3, *Operational Procedures*, 4.1.
[8] AFI 13-1AOC, Volume 3, *Operational Procedures*, Figure 4.1.
[9] AFI 13-1AOC, Volume 3, *Operational Procedures*, 4.5.2.
[10] AFI 13-1AOC, Volume 3, *Operational Procedures*, 4.5.3, 4.5.5.
[11] AFI 13-1AOC, Volume 3, *Operational Procedures*, 4.5.4.
[12] AFI 13-1AOC, Volume 3, *Operational Procedures*, 5.1.
[13] AFI 13-1AOC, Volume 3, *Operational Procedures*, Figure 5.1.

targets.[14] These specialized cells require extensive weapon system expertise in order to be effective under tight time constraints.

The Intelligence, Surveillance, and Reconnaissance Division (ISRD) and the Air Mobility Division (AMD) provide the JFACC centralized control for coordinating high value assets across multiple commands. The ISRD delivers actionable intelligence and the ability for post-strike assessment.[15] This intelligence requires coordination with numerous external agencies to bring intelligence support to the JFACC and subordinate commanders. Similarly, the Air Mobility Division is responsible for integrating external mobility capability into the total effort for the JFACC. This capability includes intra-theater airlift, aeromedical evacuation, and air refueling.[16]

Each of these divisions is critical to delivering airpower to specific theater needs. While the AOC is scalable in size depending on scope of the operation, all five divisions remain necessary for the delivery of effective airpower to the JFC. For this discussion, we will utilize the absolute definition of redundancy, a complete replacement of all of the AOC divisions. Conversely, attempts to conduct partial redundancy of specific divisions or teams fall under the concept of split operations. Split operations are a subset of distributed operations, which the next section covers as a resiliency concept.

Conceptually, one of AOC redundancy's greatest advantages is simplicity. If an adversary's kinetic or non-kinetic actions disrupt the primary AOC, an alternate AOC provides the operational level leadership required to continue combat operations. Under this model, the new AOC can be physically located either nearby or in a geographically separated location with its own communications suite. Personnel may come from

[14] AFI 13-1AOC, Volume 3, *Operational Procedures*, 5.5.2.3.2
[15] AFI 13-1AOC, Volume 3, *Operational Procedures*, 6
[16] AFI 13-1AOC, Volume 3, *Operational Procedures*, 7.1.1

an existing staff or an external staff that deploys to fill in until the original AOC returns to operating capacity.

Distributed

The concept of distributed operations covers a wide range of options. Early definitions in academia and doctrine typically include multiple independently capable nodes and redundant centralized systems similar to those defined in the preceding section.[17] Current doctrine expands the definition for distributed operations as "independent or interdependent nodes or locations participate in the operational planning and/or operational decision-making process."[18] While Air Force doctrine, instructions, and procedure manuals consistently utilize the term distributed operations for ensuring resiliency in a contested environment, none provides specific guidance.[19] This section attempts to define both independent and interdependent distributed operations.

Independent distributed operations divide portions of the airspace into manageable chunks and provide C2 for assigned forces. Analogous to the "route package" system utilized during the Vietnam conflict, loss of capability in one segment does not affect the remaining battlespace. Just

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[17] RAND's 1960 study on distributed command and control in a nuclear environment viewed distributed as multiple nodes capable of independent operations grouped in a non-hierarchical system. Air Force doctrine defined redundant AOCs as a type of distributed operations in the 2008 version of AFDD-2. However, the 2008 doctrine contained wide-ranging definitions that include independent and interdependent nodes similar to current doctrine. In order to provide a more complete analysis, the author separated singular redundant from distributed definitions. Paul Baran, *On A Distributed Command and Control System Configuration,* 34; AFDD 2-8, *Command and Control*, 79.

[18] Air Force Doctrine Annex 3-30, *Command and Control,* 7 November 2014, 23.

[19] Air Force Doctrine Annex 3-30, AFI 13-1AOC, Volume 3, and AFTTP 3-3.AOC all mention distributed operations and the requirements for commanders to explicitly define authorities and roles. None of these documents provides an example concept of operations (CONOPS). Air Force Doctrine Annex 3-30 specifically defines distributed operations as providing a more survivable command and control capability. AFTTP 3-3.AOC recommends developing a concept of operations for distributed operations in a degraded environment. Air Force Doctrine Annex 3-30, *Command and Control*, 23; Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.AOC, *Operational Employment: Air Operations Center,* 31 January 2014, 1-1.

as in Korea and Vietnam, this also allows for dividing forces among mission types, such as single control of strategic capable bombers separate from tactical fighters.[20]

Interdependent nodes provide a more complex solution to providing resiliency. Through interdependent distributed operations, commanders utilize geographically separated components of the AOC system to centralize command and control. Split operations are the most common example of an interdependent node approach to C2.[21] Through split operations, a single commander has oversight of all operational aspects.

Authorities – Distributed

As in redundancy, distributed operations for resiliency avoid changes to height of execution while altering depth of command. With multiple independent nodes, the JFACC splits authority among multiple commanders based on either geography or mission area. The decision to divide authority can be automatic or contingency based, applying only if an adversary or operational limitations disrupt the primary AOC. The result is distribution of depth of command in a theater so that the loss of one node does not affect the depth of command elsewhere in the theater. Effectively, the theater now has multiple single nodal command and control systems.

Distributed operations through interdependent nodes, including split operations, maintains depth of command through the JFACC and does not provide specific authority for subordinate commanders. Just as in independent nodes and the redundancy approach, height of execution remains unchanged. If disconnected from the JFACC's explicit guidance,

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[20] For expanded information on the route package system and division between strategic and tactical forces, see Chapter 2 in the section entitled "Korea and Vietnam – The Interservice Hurdle."

[21] This study does not include "reachback" as an organization C2 concept since it is a support function and does not include operational decision making. Air Force Doctrine Annex 3-30, *Command and Control*, 24.

the distributed construct does not provide specific authority for subordinate commanders to act.

The AOC - Distributed

The AOC has two distinct forms under distributed control: independent and interdependent. Independent AOCs provide C2 for geographically or mission defined commanders.[22] Specially authorized commanders conduct C2 through scaled versions of the Air Operations Center that may or may not include all five divisions or teams depending on JFACC intent. For instance, an independent scaled AOC may not include an Air Mobility Division if there are no assigned air mobility forces, or if there is a separate theater AOC for air mobility operations. When divisions or teams are not present, liaison officers fill the missing role by coordinating with outside agencies to fill requirements. In this case, outside agencies provide a supporting role to independent distributed AOCs.[23]

An interdependent AOC creates all five divisions through geographically separated entities. A single AOC division in its most complex form could include teams in multiple locations. In the simplest of interdependent AOCs, split operations, the AOC is primarily composed of a forward deployed component and a rear component. The JFACC centralizes effort among the geographically separated entities through information technology.[24] Each component communicates vertically as well as horizontally, just as in a physically centralized AOC concept.

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[22] Geographically defined commands resemble the Vietnam Route Pack system previously addressed in Chapter 2, "Korea and Vietnam – The Interservice Huddle". Mission defined commanders may include specialized non-geographically defined capabilities such as strategic bombing or airlift. Mission defined command was a intraservice hurdle for centralized command discussed in Chapter 2 starting with the section entitled "WWI and WWI – First Contact with Centralization".
[23] Air Force Doctrine Annex 3-30, *Command and Control*, 23.
[24] Air Force Doctrine Annex 3-30, *Command and Control*, 24.

Both of these concepts for distributed operations required personnel assigned or attached to the JFACC.[25] Under independent distributed operations, each AOC is stand-alone, requiring a scaled version that is presumably smaller than the primary AOC. This approach conservatively requires at least twice as many personnel as a standard wartime AOC. This is because the commander must man the primary AOC along with multiple forward AOCs. Assuming the JFACC does not want to lose capability in the primary AOC, personnel for forward AOCs come from either existing operational staff that must be backfilled or from AOC staff from a separate command.

Conversely, interdependent AOCs require approximately the same number of personnel as a single, geographically bound AOC conducting the same operational plan. Personnel for distributed or forward nodes come from the primary AOC and commander's staff.

Organic

Joint and Air Force doctrine does not define organic as a command and control concept. As such, this section contains more information than the preceding sections in order to explain a concept that currently has no institutional history.

American architect Frank Lloyd Wright first coined "organic" as a design principle. Wright's organic design concept determines form from nature, seeks simplicity, and finds solutions from within.[26] As seemingly abstract as this idea was, Col John Boyd proposed organic design as a solution for command and control, which he coined as appreciation and leadership.[27] Col Boyd's organic solution was a counter to the increasing

[25] Air Force Doctrine Annex 3-30, *Command and Control*, 23.
[26] Frank Lloyd Wright, *The Natural House*, (New York: Bramhall House, 1954), 3.
[27] John Boyd, "Organic Design for Command and Control", briefing slides dated May 1987, slide 32.

use of technology to centralize command and control during the 1980s.[28] He focused on trust and the implicit nature of humans to overcome friction in combat.

By taking advantage of trust and implicit communications, Col Boyd's approach empowered lower level initiative in harmony with higher-level intent.[29] Implicit communications and trust is a "consequence of the similar mental images or impressions each individual creates and commits to memory by repeatedly sharing the same variety of experiences in the same ways."[30] Similar to the concept of commander's intent in mission command, implicit communication develops harmony between senior commanders and subordinates when communication is no longer possible.[31] Through harmony and initiative, Boyd sought to "diminish friction and compress time, hence gain both quickness and security" to defeat an adversary.[32]

Although John Boyd's intent was to conduct command and control in a more decentralized way, it provides a conceptual basis to execute the JFACC's intent.[33] Organic design as presented here seeks to build trust and implicit communication inside of a theater so that if explicit communication is lost with the JFACC, subordinate commanders can continue to operate with higher-level intent. In this manner, no matter how effective an adversary's disruption of centralized C2, subordinate

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[28] John Boyd, "Organic Design for Command and Control", slide 2.
[29] John Boyd, "Organic Design for Command and Control", slide18.
[30] John Boyd, "Organic Design for Command and Control", slide18.
[31] JP 3-31, *Command and Control for Joint Land Operations,* identifies implicit communication as a requirement for mission command. Joint Publication (JP) 3-31, *Command and Control for Joint Land Operations,* 24 February 2014, IV 8-9.
[32] John Boyd, "Organic Design for Command and Control", slide 18.
[33] John Boyd asserted in his 1987 briefing, *Organic Design for Command and Control,* that the term command and control was not appropriate to associate with organic design. These terms are used together here since this paper does not fully adopt Col Boyd's ideas and for simplicity. John Boyd, "Organic Design for Command and Control", slide 35.

commanders are appropriately empowered through authorities and have a full understanding of commander intent to continue operations.

In Betts' C2 mental model, a zone of adaptive control (reference Fig. 1-2) provides flexibility for a senior commander to set the level of centralization based on authorities given to a subordinate commander. While adaptive control provides a useful model for understanding how to enable capacity for adaption in a C2 system, it only partially accounts for the dynamics of a contested environment and underemphasizes the historically proven value of centralized control. Unlike adaptive control, graceful degradation seeks to achieve centralized control to the maximum extent the contested environment will allow. Through graceful degradation, the command and control system is able to continue operations when contested, albeit at a reduced effectiveness through decentralization, and return to maximum centralization when no longer contested. Graceful degradation provides resiliency while still recognizing the supremacy of centralized control of airpower. Instead of insisting control "by a single Airman who maintains the broad, strategic perspective necessary," the organic approach seeks the ability to gracefully degrade between control by a single airman to control by multiple subordinate commanders and return.[34]

[34] Air Force Doctrine Volume 4, *Air Force Operations Doctrine*, 5 June 2013, 14.

Just as in adaptive control, graceful degradation requires height of execution to exceed depth of command in order to be effective (see Fig. 4-1).[35] As the overlap between the two elements increases, so does the range of graceful degradation. The range of graceful degradation represents the organizational ability to absorb adversary disruption. Similar to adaptive control, without height of execution for subordinate commanders at the operational level, graceful degradation is not possible.

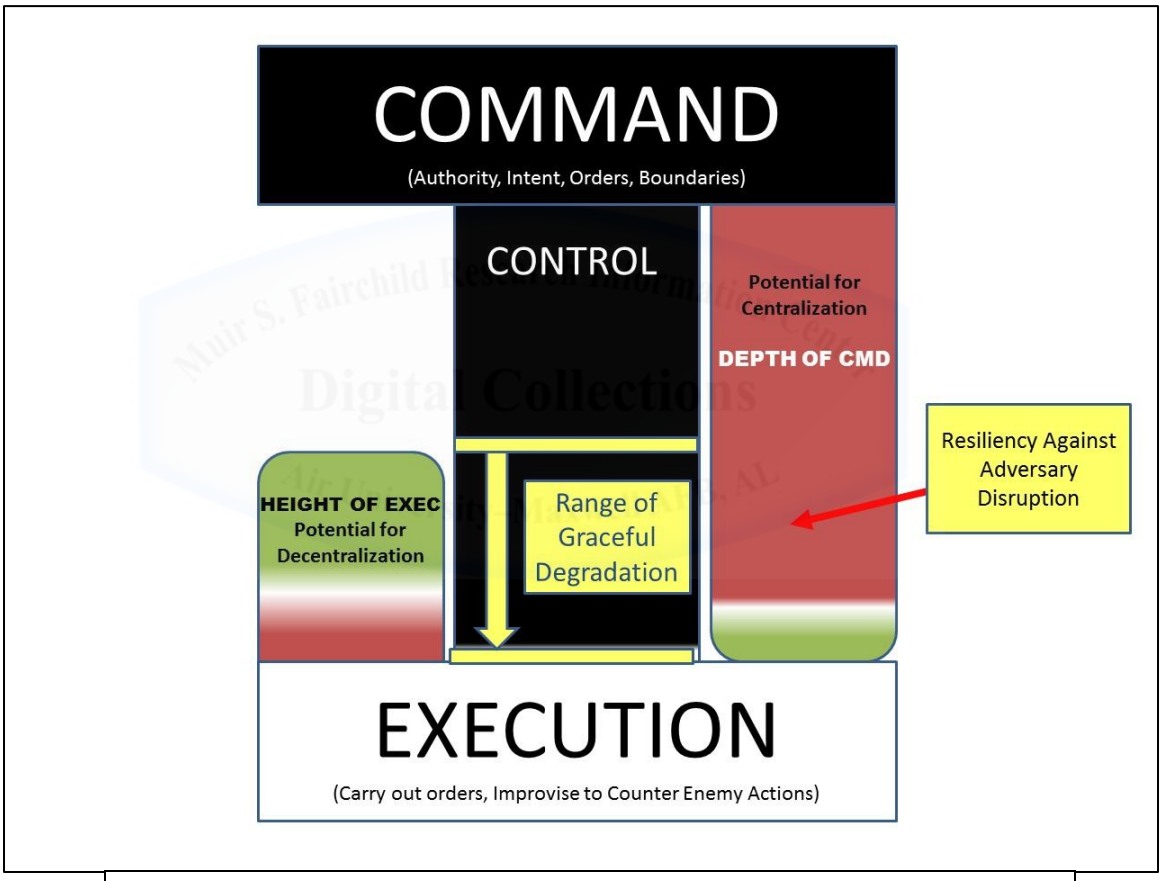

Fig. 6 The C2 Mental Model adapted for graceful degradation.

[35] The author created this figure utilizing Betts' C2 Mental Model. William Betts, "Airpower's Master Tennent and Anti-Access/Area Denial: Hope Is Not a Course of Action" (Thesis Air War College, Air University, 2014), 6.

Authorities - Organic

The first step to increase the height of execution is to provide subordinate commanders the authority they need to conduct operations when disconnected from the AOC. Authorities provide the commander the power to disseminate orders and enforce their compliance. They also provide subordinate commanders guidance through commander's intent and bounds for actions in a specific threat environment. Without delegated operational authority, forward commanders cannot legitimately execute the *Decide* portion of John Boyd's OODA Loop beyond the existing ATO, thereby leaving the organization paralyzed and unable to gracefully degrade.

Fortunately, authorities, unlike resources, are easily and cheaply defined on a contingency basis. Tactically, the Air Force is institutionally comfortable providing front line leaders with authority to make decisions based on a commander's intent when unable to reach back for guidance. However, operationally, the Air Force has failed to provide the trust necessary for subordinate commander initiative by giving them the authority to continue operations in a contested command and control environment. By instilling trust through pre-designated protocols for assumption of authority during periods of disruption, the Air Force sets the conditions for initiative by subordinate commanders.

Providing contingency authority to subordinate and coordinated commanders places airpower firmly in the dominant construct of mission command.[36] However, unlike maritime or land forces that are physically limited in their span of influence, air forces have the potential to impact operations anywhere in a theater on a single mission. As a result, the JFACC staff must specially tailor and fully develop authorities for specific commanders under multiple contingencies. Contingency-based

[36] Chapter 1 provides further explanation and doctrinal definitions for mission command under "Command and Control Concepts and Doctrine."

authorities for airpower identify the level of C2 disruption along with the strategic risk to determine the proper extent to which commanders are able to execute. As C2 disruption fades, contingency authorities are no longer valid. Just as important as providing trust in the subordinate, this provides trust back to the JFACC that subordinate commander initiative will fall within his or her intent.

Utilizing authorities to instill commanders with operational responsibility is the first step to creating resiliency. However, in order to enable graceful degradation, commanders will require physical and cognitive resources as well. Organic design provides an approach to providing these resources through the AOC.

The AOC - Organic

Under the Organic construct, in order to enable participation at every level, subordinate commanders designate an Organic AOC staff. The Organic AOC staff organizes under the current five-division AOC structure and, like the AOC, is scalable and flexible. The organic concept virtually combines forward personnel from subordinate and coordinated commanders with primary AOC personnel co-located with the JFACC.[37] AOC staffs and subordinate commanders determine the makeup of the Organic AOC staff billets based on their command's combat capability and capacity. For example, a subordinate commander with a significant fighter aircraft allocation would have personnel directly engaged in strategy, combat operations, and combat plans divisions. The commander's weapon system allocation, personnel available, and AOC theater responsibility determine the total number of organic personnel

[37] Matrix organization refers to the dual hatting of personnel who are under a separate command than the AOC divisions they work with. Any references to "Legacy AOC" refer to the existing model of AOC personnel co-located with the JFACC.

designated.[38] Subordinate and coordinated commanders now have airmen in a relevant portion of the AOC directly under their command.

Even though Organic AOC personnel do not physically reside in the AOC, legacy AOC personnel and information technology centralizes their efforts. Through networked peer-to-peer communication relationships, organic staffs are both producers and consumers of data.[39] AOC division and team leaders, manned from legacy positions co-located with the JFACC, coordinate individual and collaborated tasks among Organic AOC personnel. By participating in the JFACC's Air Tasking cycle, organic personnel share experiences and observe JFACC decisions necessary to build implicit communication and trust. As a result, Organic AOC personnel directly affect and have access to the JFACC's *Orientation.*

Although the Organic AOC construct provides added value in the heirachical operations, it has significant lateral coordination value as well. Organic AOC personnel from multiple subordinate commanders along with legacy personnel compose an AOC division or team. As organic personnel perform collaborative tasks, they build a formal lateral communication and coordination capability. Not only are organic personnel communicating while accomplishing Air Tasking Cycle tasks, they are sharing the same *Orientation*.

An Analysis of Redundant, Distributed, and Organic C2 Resiliency

[38] AOC theater responsibility depends on expectations for sortie production and span of influence for individually tailored AOCs.

[39] Peer-to-peer networks allow resilient distributed data sharing without the requirement for a centralized node and provide continuous data sharing capability even as external effects disrupt users. As an example, the long defunct Napster was a peer-to-peer information-sharing network. However, the author recommends considering a modified version of peer-to-peer sharing where the legacy AOC provides access to a centralized server for data storage in addition to peer-to-peer sharing. Definition derived from Ralf Steinmetz and Klaus Wehrle, *Peer-to-Peer Systems and Applications* (Berlin: Springer-Verlag, 2005), 1-5.

Analyzing resiliency in a command and control system is difficult and heavily dependent on expectations, adversary capability, and resources available. Chapter 2 began by defining resiliency as the ability to "bounce back" from an adversary's actions.[40] The International Council on Systems Engineering (INCOSE) more expertly defines resiliency as "the capability of a system with specific characteristics before, during and after a disruption to absorb the disruption, recover to an acceptable level of performance, and sustain that level for an acceptable period of time."[41] Although an "acceptable level of performance" is imprecise, this component of the definition provides an understanding of the elements involved and why they are so difficult to measure.

Commander expectations are not the only measure for determining an "acceptable level of performance" for military command and control; adversary capabilities are important as well. Adversary capabilities include both the ability to cause disruption and the ability to take advantage of any opportunities caused by disruption. These capabilities can vary greatly across a large spectrum of operations. In order to simplify the discussion, two types of adversaries are considered: a limited adversary and a credible adversary. This section defines a limited adversary as capable of causing C2 disruption through a sudden action, kinetic or non-kinetic, with marginal capability to conduct follow-on actions. On the other end of the spectrum, a credible adversary can

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[40] This definition of resiliency utilizes Mark Pflanz and Alexander Levis' short definition in "An Approach to Evaluating Resiliency in Command and Control Architectures" and the concept of adversary initiation from *Understanding Command and Control*. Mark Pflanz and Alexander Levis, "An Approach to Evaluating Resiliency in Command and Control Architectures," New Challenges in Systems Engineering and Architecture Conference Paper, Organized by Missouri University of Science and Technology, 2012; David S. Alberts and Richard E. Hayes, *Understanding Command and Control* (Washington D.C.: Command and Control Research Program [CCRP], 2006), 187.

[41] Scott Jackson, "INCOSE Resilient Systems Working Group Charter." A charter to define the principles of resiliency by the International Council on Systems Engineering (INCOSE), November 13, 2010.

cause disruption through multiple means, kinetic and non-kinetic, and sustain disruption over time at multiple nodes.[42] As such, this section discusses adversary capability at the two extremes of capability to contest command and control: limited and credible. However, in reality there are multiple degrees of variance between these two points for consideration as well.

In order to determine the best approach for providing resiliency in command and control of airpower this section will conduct an analysis of the three concepts defined; redundancy, distributed (both independent and interdependent), and organic. The approach to the analysis begins by applying the framework developed in Chapter 3 based on historical study and the existing operational problem. The intent of the application of this framework is not to declare a winner but to highlight the strengths and weaknesses of each approach in order to make an informed decision regarding C2. Table 4-1 provides the results in an easy to read format with the corresponding logic below. With this in hand, a discussion about what the results provide and how to determine an appropriate way ahead for ensuring C2 resilience follows. [43]

Framework Applied

Maximize Centralization

Of the three concepts, redundancy best maximizes centralization as long as an adversary is unable to disrupt alternate or additional AOCs. Redundancy provides additional identical structures for a single airman to continue maximum depth of command. This concept is particularly useful against a limited adversary such as Iraq during the

[42] INCOSE defines disruption as an "initiating event of a reduction is performance. A disruption may be either a sudden or sustained event." This section utilizes the INCOSE definition to define two specific types of disruption, sudden and sustained. Jackson, "INCOSE Resilient Systems Working Group Charter," 1.
[43] The section entitled "A Critical Framework for Evaluating C2 Resiliency" in Chapter 3 defines each of the five framework components utilized here.

1991 Gulf War. As the Iraqis were only able to contest C2 kinetically through inaccurate missiles, an alternate AOC would have provided Gen Horner the ability to continue operations in the unlikely event that Iraqi forces were able to disrupt the primary AOC. However, against a credible adversary, each AOC nodes provides an additional centralized C2 system that provides a single nodal target similar to each other for creating disruption. The redundancy concept provides centralized C2 or none at all, depending on adversary capability.

In order to analyze centralization for distributed operations the type of approach must be defined as independent or interdependent nodes. Independent distributed operations are regionally centralized. Although the JFACC is capable of providing guidance to each regional AOC, the low interaction between physically and cognitively separated AOCs limits the impact of that communication. Even against a credible enemy, physically separated region or mission areas can maintain a reduced level of centralization in their independent spheres.

Centralization among interdependent distributed operations varies greatly. This is heavily dependent on how the AOC is constructed and where the JFACC is physically located. For instance, a split operation with a forward deployed JFACC is still capable of conducting operations when isolated from the rest of the AOC, although at a significantly reduced effectiveness. In this case, when an adversary disconnects the JFACC from the rest of the C2 structure, a forward JFACC retains some ability to conduct centralized operations with co-located forces through physical correspondences. Conversely, a JFACC deployed to the rear and disconnected from forward forces has no capability to conduct centralized control of airpower.

Unlike redundancy, the organic concept provides no alternate avenues to centralize airpower at the JFACC when disrupted. Graceful

degradation through organic design allows centralization at the highest level allowed by adversary disruption. The organic approach attempts to replicate centralization through implicit communication. Implicit communication ensures that decisions made by subordinate commanders reflect the JFACC's intent. In this manner, all actions have an inherent element of centralization.

Eliminate Operational Gaps

Of the three approaches, redundancy provides the greatest risk for operational gaps. Redundancy requires physical movement by the JFACC to an alternate AOC. Additionally, the impact disruption has on the AOC staff depends on both the redundancy design and adversary actions. If the original AOC staff is capable of movement to the alternate AOC and is able to transfer information as well, disruption will only amount to the time requiring physical movement. However, if designating an alternative AOC staff is required as well, the total time of disruption will increase based on the ability to develop cognitive continuity with the theater and forces. Cognitive continuity is the ability for new or additional AOC personnel to understand theater *Orientation* as determined by the JFACC in order to make accurate operational decisions. It takes time to develop this, and that time manifests itself as gaps in operational capability.

An independent distributed operation allows for geographical or mission capability gaps from disruption but maintains some level of operational capability against all but the most credible adversary. Unless an adversary is able to disrupt every independent AOC and prevent physical correspondence, independent distributed operations ensures operational capability in some areas. Unfortunately, this also allows an adversary to determine where operational gaps will exist by disrupting specific independent AOCs.

Similarly, interdependent operations will always have some level of operational capability if connected to a forward deployed JFACC. The extent to which the JFACC can communicate with co-located or adjacent forces through physical correspondence determines the operational gap. Unlike independent nodes, the JFACC determines the total operational capability through forward deployment and communication means available. However, a credible adversary will be able to determine which forces and capabilities are isolated and where the operational gaps reside based on the JFACCs location and communicative capability.

Built on contingency authorities and height of execution, the organic approach has minimum operational gaps. The JFACC determines those gaps, if they exist, in advance by setting limits to authorities of forward commanders. Subordinate commanders retain the authority to operate under organic design as well as the resources required for planning and coordination when disconnected from explicit JFACC input. Under organic design, the adversary also has the least capability to influence or determine operational gaps. Even a credible adversary that can disrupt multiple communication nodes will still have to contend with fully empowered subordinate commanders.

Rapid Employment

Although redundancy can utilize existing alternate AOCs and staffs, the cognitive limitations addressed under “Eliminate Operational Gaps” create a time requirement that slows the speed of employment. Therefore, the time required for a staff to build cognitive continuity determines how rapidly redundant AOCs employ.

One solution to minimizing the time required to gain cognitive continuity is through shadowing, or standing up an alternate staff that receives all of the same information and follows decision cycles of the primary AOC. While shadowing does help facilitate a quicker return to

operations from the loss of a primary AOC, the extent to which redundant AOC personnel are engaged in the process mitigates the effectiveness. Through shadowing by a full time staff, a redundant AOC can minimize the time required for full employment. However, this solution comes with extensive personnel requirements. The critical framework component "Resource Stewardship" addresses this impact.

Both independent and interdependent distributed operations require long lead times for forward deployment and organization of personnel. In addition to movement time, staffs pushed forward suffer from the same lack of cognitive continuity and command confusion as redundant AOCs. Depending on where forward staffs are pushed, the mobile communication infrastructure necessary for effective C2 may require time to become operational as well. Against a limited adversary, the lead-time required may be of marginal impact. However, long lead times against a credible adversary results in a loss of initiative, enabling denial of effective theater command and control of airpower. Just as in redundancy, distributed operations staffs require pre-deployment of personnel and resources to enable rapid employment. Once again, this negatively impacts "Resource Stewardship."

Alternatively, the organic approach utilizes personnel already associated with the projection of airpower. Designated by subordinate commanders, these personnel engage with the AOC cycle from the earliest moment possible. Already functioning at the time of disruption, there is no delay in the employment of an organic AOC.

Maximize Theater *Orientation*

A line drawn from redundancy through distributed and ending with the organic concept for resiliency represents a continuum of increasing theater orientation. Redundant AOCs, when requiring a completely different staff, require the greatest amount of effort to develop

a shared O*rientation* with the JFACC. Particularly when involving staffs from a separate command, the difference in *Orientation* between the new AOC staff, the JFACC, and forward deployed forces can be overwhelming. As addressed above, the only solution to overcome this is through either time or shadowed staffs.

Distributed operations push staffs forward to develop theater *Orientation*. By forward deploying these staffs and collocating them with subordinate commanders and air forces, theater *Orientation* develops much more quickly and is more complete than with redundant staffs. With time or with constantly deployed staffs, distributed operations develop a shared theater *Orientation*.

Just as distributed staffs benefit from forward deployed personnel, organic staffs are embedded with forward forces exclusively. Organic design intentionally maximizes shared theater *Orientation* to enable implicit communication with the JFACC. This shared O*rientation* is not dependent on time or changes to personnel in order to be effective. In the event of disconnection, over time the *Orientation* of disconnected commanders will drift apart from each other and the JFACC. Restoration of communications allows the return to a common *Orientation* to the extent that communicative capability allows. Even a minimum communication capability with the JFACC allows adjustments of intent while subordinate commanders continue to execute the Air Tasking Cycle. Potentially, depending on how long and to what extent the primary AOC communications were disrupted, subordinate commanders may actually provide a greater capability to restore theater *Orientation* than a disconnected JFACC.

Resource Stewardship

At this point, previous components of the framework discussion have already highlighted resource stewardship issues for both redundant

and distributed operations. Addressed simply, the more credible the adversary, the more these approaches require pre-designated and forward deployed personnel and communication resources. In order to be effective, these staffs have to be consistently involved with the Air Tasking Cycle. Redundancy requires a completely duplicative staff that is ineffectual during uncontested operations. The distributed concept does not require as great a personnel commitment for interdependent operations, but independent staff nodes are duplicative as they attempt to replicate the AOC at a smaller scaled level. Multiple independent AOCs capable of conducting operations in separate geographic areas will require

Further exacerbating this heavy resource requirement is the historical lesson that AOCs during wartime at least double in size from their non-contingency manning.[44] If we utilize notional AOC manning numbers derived from history, a peacetime AOC manning is 500 personnel or less and doubles to over 1,000 personnel during wartime. Under a redundancy system, the primary and alternate AOC requires over 1,500 additional personnel during contingency operations. An independent distributed operation would require a primary AOC staff of 1,000 personnel and, conservatively, 500 personnel per independent AOC. An interdependent operation would require the least number of additional personnel at approximately 500 to fill the difference from peacetime to wartime.

Each of these solutions requires additional personnel that require a lead-time to develop theater *Orientation*. While this is acceptable against a limited adversary, a credible adversary can take advantage of

[44] AOCs double in size or more during contingency operations. During the 1991 Gulf War the TACC (AOC predecessor) grew from 300 to 2,000 personnel. During Operation Allied Force, the AOC grew from a peacetime manning of 400 to more than 1,300 personnel. See Chapter 3 “Centralization and the Operational Level of War Problem” for an expanded discussion on AOC manning.

this lead-time through preemption to meet its objectives. In order to reduce or eliminate the lead-time, each solution would have to sustain the deployment of these additional personnel in order to mitigate risk from a credible adversary.

The organic approach builds on the expertise and *Orientation* of personnel already in theater. The optimized size for a notional Organic AOC is slightly larger than the difference between a peacetime and wartime AOC. In the notional case that is just over 500 multi-tasked personnel already deployed in theater. These organic personnel do not require the lead-time the other solutions require to develop theater *Orientation.* In this manner, the organic approach is acceptance of AOC manning requirements in advance of contingency operations and risk mitigation against preemption by a credible adversary.

	Redundancy	Distributed - Independent Nodes	Distributed - Interdependent Nodes	Organic
Maximize Centralization	Limited Adversary: Maximum centralization Credible Adversary: High risk of zero capability	Regionally or Mission Area centralization	Limited to JFACC physical correspondence	Centralized to highest level possible / implicit communication
Eliminate Operational Gaps	Gaps in time (time determined by physical movement and cognitive continuity)	Regional or Mission Area Gaps determined by adversary	Gaps in forces not co-located with JFACC or outside of area of physical correspondence	Gaps determined by JFACC through contingency authorities
Rapid Employment	Long employment delays without prepositioned forces	Long employment delays without prepositioned forces	Long employment delays without prepositioned forces	Always employed
Maximize Theater *Orientation*	Theater *Orientation* requires long lead-times or shadow staffs	Theater *Orientation* built from forward deployed staffs engaged with forces / Regional commanders forward	Theater *Orientation* built from forward deployed staffs engaged with forces / JFACC forward deployed	Shared theater *Orientation* with JFACC / enhanced through use of organic personnel
Resource Stewardship	Large personnel resource requirement for mitigation of credible adversary	Largest personnel resource requirement for mitigation of credible adversary	Additional personnel only required for wartime plus up	Existing use of organic personnel does not change based on adversary or onset of hostilities

Table. 1. Framework Results

Discussion

Each of the concepts discussed—redundant, distributed, and organic—has overlapping elements and represents an evolutionary development of resiliency. Redundancy, the most common and simplest approach to resiliency, is a significant component of both independent and interdependent distributed operations. While a distributed operation takes the redundancy concept and brings it forward into the theater, the organic approach builds on the distributed concept and couples it with contingency authorities.

This increasing complexity from redundancy through organic is reflective of an increasingly credible adversary. The idea of a redundant or distributed independent command and control system in the 1991 Gulf War was more than capable of mitigating the limited amount of risk posed by Iraqi forces. At the time, there was minimal risk of disruption to the United States' ability to communicate with fielded forces. Nearly a quarter of a century later, Chinese and Russian counterspace capabilities hold space-based communication at risk while state and non-state hackers threaten information operations in the cyber domain.[45]

Just as the threats to the command and control system become more credible, so has the ability for adversaries to take advantage of a disruption in airpower. The capability and capacity for power projection has been resurgent since the end of the Cold War. Russian Bear bombers

[45] James R.Clapper, *Worldwide Threat Assessment of the US Intelligence Community* (Washington DC: Senate Select Committee on Intelligence, 2013), 1-3, 9. Department of Defense, *Annual Report to Congress on Military and Security Developments Involving the People's Republic of China: 2010* (Washington DC: Government Printing Office, 2010), 30.

have returned to NATO borders.[46] China's first aircraft carrier conducts trials at sea, while a second sits under construction in port.[47] North Korea claims its submarines are now capable of ballistic missile delivery while that nation continues to develop its nuclear weapons program.[48] A disruption in execution of airpower, coupled with any of these capabilities, is potentially catastrophic to American security interests.

In order to meet these evolving threats, command and control of airpower requires a more complex form of resiliency. The organic approach best represents the next benchmark for C2 allowing graceful degradation in the control of airpower. By utilizing forward forces, organic command and control is always ready and requires no lead-time or advanced warning. It denies an adversary the value of preemption and mitigates the impact of disruption. It assures an immediate and effective response to deter aggression against the United States and its allies. Built on implicit communication and contingency authority, organic C2 is predictable for JFACC led forces even while remaining unpredictable to an adversary. In response to an increasingly credible adversary, the United States Air Force should adopt and integrate the organic concept for command and control in the future.

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[46] "RAF Jets Scrambled After Russian Bombers Seen Off Cornwall", British Broadcasting Corporation, http://www.bbc.com/news/uk-31530840, accessed 10 May 2015.

[47] James Holmes, "The Long Strange Trip of China's First Aircraft Carrier", *Foreign Policy,* (February 3, 2015), http://foreignpolicy.com/2015/02/03/the-long-strange-trip-of-chinas-first-aircraft-carrier-liaoning/ (accessed 10 May 2015).

[48] Many analysts dispute North Korea's claims of a submarine launched missile. However, the intent of these claims, to provide a power projection capability for North Korea, is unmistakable. Kim Jong-Un described the submarine launched missile as a "world-level strategic weapon". "North Korea Could Have Missile Submarines in Five Years, Says South", British Broadcasting Corporation, http://www.bbc.com/news/world-asia-32686364 (accessed 15 May 2015).

Chapter 5

Recommendations and Conclusion

Although graceful degradation through organic design builds upon existing doctrine and the master tenant, it will require institutional change and investment in order to be successful. Fortunately, organic design relies heavily on existing personnel and established operational processes, thus minimizing the physical changes required. In order to enable organic design, the Air Force must adjust how it organizes, trains, and equips to ensure command and control resiliency for the future.

Organize

The Organic AOC is the cornerstone of change proposed in this monograph and is a departure from the model which the Air Force has traditionally organized command staffs around since 1991. However, opportunity exists, even in a resource-limited environment, to conduct organizational adjustments at small, incremental levels. Instead of trying to develop a fully functional and capable organic AOC all at once, Air Force component staffs should identify specific commands and process components for operational testing and development of organic design in current operational theaters.

For instance, in PACAF, the inclusion of organic staffs can begin with the largest forward deployed wings and the most relevant critical processes within the Air Tasking Cycle. One example is designating staff from a fighter centric wing and integrating their organic staff into the legacy AOC Master Air Attack Planning and ATO production teams.[1] Integration into these two teams alone will have an immediate impact. Through organic staffs, an isolated wing will understand through implicit communication the JFACC's intent and expected sortie production at the

[1] For more information on the roles of the Master Air Attack Planning and ATO production teams, see Chapter 3, "The AOC – Redundancy".

onset of hostilities. From the outset, inclusion of organic staffs will foster better *Observation* and *Orientation* for the JFACC and AOC staff. As staffs identify lessons learned and best practices, the organic AOC concept can grow, expanding in scope and command implementation.[2]

An incremental approach to the development of contingency authorities also provides a vector for identifying which portions of the AOC should have organic elements first. Early contingency authorities will most likely focus on ensuring conduct of air defense missions when adversary action contests or disrupts communication with the AOC. Through codified contingency authorities, the wing level is now responsible for the conduct of specified tasks and can adjust its staff accordingly to ensure success. In this way, a wing can utilize its contingency authority to prioritize the most appropriate organic capabilities to develop with the resources at its disposal.

As contingency authorities are further developed and exercised, they provide an avenue to develop trust in organic execution by subordinate commanders and expand their role. Early low strategic risk contingencies such as air defense, when operated organically through exercise roles, will provide insight on how to develop and define the conditions for the next level of authorities.

Train

Unfortunately, the personnel trained in AOC processes required to make an Organic AOC possible are not plentiful in the Air Force. Low demand has resulted in low production of qualified personnel. Once again, an incremental approach allows commanders to take advantage of the limited trained personnel they do have and train the remaining

[2] The notional growth of an organic AOC is slightly larger than the size of the AOC during peacetime. This provides roughly the growth necessary for contingency operations.

personnel required while the Air Force develops an institutional solution to operational level training.

Just as in the 1991 Gulf War, there is room to train organic staffs internally with legacy AOC personnel.[3] Instruction can even include "hands-on" training by sending designated personnel to component AOCs for short stays. However, this is an inefficient approach and limits the ability to expand Organic AOCs in size. In response, the Air Force must increase enrollment capability of its formal AOC instruction school and develop specialized distance learning products. By providing multiple tiered options for training, commanders have flexibility to develop their organic staffs as needed.[4]

Nearly any solution to resilient command and control will require additional trained personnel. Organic design as a solution places a high premium in personnel trained in operational processes and planning for employment of airpower. As such, it is worth revaluating Air Force professional education and training schools to find opportunities to instill an increased level of operational knowledge in the force.

The Organic AOC, along with newly developed training, will require adjustment to doctrine. While reaffirming that the history proven centralization of airpower under a single airmen is still the most effective approach to airpower, Air Force doctrine must define graceful degradation along with organic design literally and conceptually. It must lay the foundational underpinnings of graceful degradation by expanding the scope of decentralized execution to include the operational level. Airmen need to address Joint Doctrine as well to institutionalize an "all-echelon" approach to command of airpower.

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[3] The Chapter 3 section entitled "Centralization and the Operational Level of War Problem" addresses just-in-time staff training during the Gulf War and Operation Allied Force in Kosovo.

[4] The multiple tiers include formal AOC schools, distance learning courses, hands-on training with theater AOCs, and informal unit level training.

Another aspect of training fundamentally altered is how the Air Force conducts exercises and inspections. Under the organic approach, a readiness exercise includes lateral and hierarchical components. For instance, operational exercises for the AOC would include the organic component throughout the command, not just the physical AOC co-located with the JFACC. Additionally, local wing level exercises should include horizontal coordination with other units at the same level of command in addition to testing the effectiveness of contingency authorities. Whereas exercise and inspections were more isolated in the past, the collaborative and shared processes of organic command and control provide both a requirement and an opportunity for change.

Equip

While it may appear counterintuitive that increasing reliance on a communication structure provides a solution to resiliency when information technology is the adversary's primary target, there are two reasons that enhancing the network communicative capability is vital. One reason is increasing connectivity among subordinate commanders develops multiple communication pathways, thereby complicating an adversary's targeting problem for disruption. The second reason is an increased communication architecture that serves organic design creates a communication solution without technology defined as implicit communication.

Enhancing a commander's communicative capability and access to tactical and operational information is a trend that will only increase in the future. Distributed communication networks must continue to develop to provide multimodal distribution of information at every echelon. By developing peer-to-peer network solutions instead of centralized information sharing, a commander's operational computing capability is more resilient as well as the organization.

Final Recommendation

This recommendation uses the incremental approach for three primary reasons. The first is that abrupt change comes with risk. It can create confusion at a critical moment, undermining the very purpose for resiliency in C2. The second reason is the nature of the resource-limited environment for the Air Force. It is unrealistic to believe that any solution requiring additional resources will be able to manifest itself overnight. The last reason is that the concepts presented herein are a design, not a prescriptive approach. Graceful degradation, through organic design, is closer to theory than practice. As such, it requires practical knowledge for successful implementation that can only be gained through operational experimentation and testing.

Through incremental and prioritized progress, the organic approach is a better solution for the future of command and control of airpower against an increasingly credible list of adversaries. In order to meet this threat, the United States Air Force needs an organizational solution that empowers commanders at every level with both authority and knowledge. Contingency authorities coupled with a shared theater *Orientation* assure strategically valuable action in the face of disruption. Ultimately, organic design is an evolutionary concept for command and control of airpower that assures the United States maintains a decisive advantage against its adversaries.

Glossary

AFDD – Air Force Doctrine Document

AMD – Air Mobility Division

AOC – Air Operations Center

ATO – Air Tasking Order

CINC – Commander in Chief

COD – Combat Operations Division

CPD – Combat Plans Division

C2 – Command and Control

FEAF – Far East Air Forces

INCOSE – International Council on Systems Engineering

ISRD – Intelligence, Surveillance, and Reconnaissance Division

JAOP – Joint Air Operations Plan

JCS – Joint Chiefs of Staff

JFACC – Joint Force Air Component Commander

JFC – Joint Force Commander

JP – Joint Publication

MAAP – Master Air Attack Plan

MAW – Marine Aviation Wing

NATO – North Atlantic Treaty Organization

OPCON – operational Control

PACAF – Pacific Air Forces

PACFLT – Pacific Fleet

SAC – Strategic Air Command

SAASS – School of Advanced Air and Space Studies

SD – Strategy Division

SIDO – senior intelligence duty officer

TACC – tactical air control center

TET – target effects team

USAF – United States Air Force

USN – United States Navy

USMC – United States Marine Corps

Implicit communication – Similar mental images or impressions each individual creates and commits to memory by repeatedly sharing the same variety of experiences in the same ways. (Source: John Boyd, "Organic Design for Command and Control", briefing slides dated May 1987, slide 18.)

Organic – Empowered lower level initiative in harmony with higher-level intent through implicit communication and trust. (Source: Chapter 4, "Organic")

Resiliency – 1. The ability to "bounce back" from an adversary's actions. 2. The capability of a system with specific characteristics before, during and after a disruption to absorb the disruption, recover to an acceptable level of performance, and sustain that level for an acceptable period of time. (Source: Scott Jackson, "INCOSE Resilient Systems Working Group Charter", A charter to define the principles of resiliency by the International Council on Systems Engineering (INCOSE), November 13, 2010.)

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